

BIM

GUIDELINES FOR VERTICAL AND HORIZONTAL CONSTRUCTION





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"The Massachusetts Port Authority (MPA) owns and operates an integrated world-class transportation network that promotes economic growth and opportunity, enhances the quality of life of New England residents, and protects the freedom to travel safely, securely, efficiently and cost-effectively."

Massport's decision to implement Building Information Modeling (BIM) represents a significant multi-year change in how Massport executes projects and develops information about its assets.

Massport uses information developed across projects and operational activities to make sound facility lifecycle decisions supporting the public good. When used successfully, BIM offers higher quality information for better decision support. This information is more coordinated, reliable and reusable, allowing Massport teams to be more productive and the design solutions functional, cost effective, and sustainable. Facilities information, created during a BIM project, can be repurposed, reducing costly information management redundancies for post construction operations.

This BIM Guide for Vertical and Horizontal Construction provides the vision and structure for Massport and its service providers, to develop successful Lean BIM projects meeting Massport's mission.

"Begin with the end in mind"
Steven Covey

"Since arriving at Massport, I have worked with others to bring our processes, people, and facility stewardship into the 21st century.

It has taken passion, enthusiasm, and determination by many people to bring about this Lean BIM vision and produce the documentation, contract, and process changes required to achieve this first milestone in our Lean BIM Roadmap.

BIM and Lean are essential enablers in Massport's strategy for innovative and normalized project delivery. We worked with our consultants and service providers to make sure that the MPA vision has community buy-in.

Massport can expect BIM to be used within a Lean collaboration environment conducive to information flow, communication, analysis, and problem solving.

I continue to be excited about how these actions and tools can improve Massport projects and facility management, and I look forward to the continued collaboration with my Massport colleagues, our design and construction community, and industry leaders to pursue innovation."



Dr. Luciana Burdi, Intl. Assoc. AIA
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REFERENCED GUIDES AND STANDARDS:

VA BIM GUIDE	PENN STATE BIM EXECUTION PLAN
AOC BIM GUIDE	AGC LOD SPECIFICATION
LACCD BIM GUIDE	USCG ROADMAP
CSI OMNICLASS	NATIONAL BIM STANDARD
	UK BIM PROTOCOLS

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Massport (MPA) Capital Programs and Environmental Affairs Department developed this BIM Guide for Vertical and Horizontal Construction for design, construction, civil, and facilities professionals working on MPA projects. It specifies the guidelines and project model standards to be used within a BIM/Lean collaboration environment. The goal of the guide is to assure consistency in processes and BIM development from MPA's various service providers across multiple types of projects.

MPA has developed a BIM template file, a BIM Execution Plan (BIMxP) template to standardize and partially automate the BIM planning activity, and provided the MPA asset classifications used in Maximo. BIM Use descriptions, which will change over time, are in Appendix A. Lean collaboration methods and modeling requirements are included in the guide to assure consistency in processes and BIM development from different service providers.

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The Guide references current industry "best practices", however technology and knowledge of BIM is continually evolving. The document will be periodically reviewed for updates.

The Guide Includes:

- MPA BIM vision and value proposition
- Collaboration for Lean BIM projects
- BIM Execution Planning and BIM Uses
- Appendix supporting model content and development
- Data standards, modeling and construction documentation requirements
- Model and project contract documents development and submissions
- Glossary



The Guide is divided into color-coded sections for easier reading and navigation by multiple stakeholders with different interests in the guide.

“Why BIM at Massport”

Clarifies MPA's facility lifecycle information vision. The MPA BIM Roadmap integrates several industry data standards, new process changes, and emerging technologies, which expands BIM use across all project types and MPA assets. This vision is supported by the Design Technologies Integration Group within MPA.

MPA’s Lean/BIM Collaboration

Is the first owner driven integration of a BIM-centric and Lean managed project lifecycle. MPA and its service providers will use these lean approaches, tools, and BIM uses to develop a unified strategy for project success. An MPA BIM Execution Plan (BIMxP) template will standardize and partially automate the project BIM planning activity.

The MPA BIM Framework

Provides the BIM Managers and Project Participants with the technical specifications and data requirements for development of MPA models. These requirements are referenced by the BIM Uses (Appendix A). MPA has developed a template for all required MPA asset classifications to be used in Maximo, MPA's Asset Management system.

The Glossary

Is comprised of definitions of terms supporting collaborative conversations regarding the BIM and Lean processes and tools used in this Guide.

Appendix A

Is the collection of MPA BIM Uses to be aligned with the project's BIM needs and Conditions of Satisfaction. These BIM Uses provide the foundation for BIM execution and collaboration. This information is constantly changing, and the appendix format will allow rapid updates based upon industry changes and lessons learned.



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Templates and Reference Standards:

- Model Template File (.rvt)
- MPAClassifications_for_Maximo_Assets2014.xlsb
 - ▶ Asset Naming Conventions
- BIM Execution Plan (BIMxP) Template
 - ▶ Clash Detection Matrix and Report

Referenced Standards and Documents:

- MPS Survey Guide – Geospatial coordination
- OmniClass Tables, MasterFormat, and Uniformat, Construction Specification Institute (CSI)
- Level of Development (LOD) 2014, AGC/AIA BIMForum
- National BIM Standard (NBIMS), National Institute of Building Sciences (NIBS)
- National CAD Standard (NCS) , National Institute of Building Sciences (NIBS)

PROJECT TYPES	ADDITIONAL DESCRIPTION	ESTIMATED CONSTRUCTION COST	REQUIREMENTS	BIM AND NON-BIM DELIVERABLES (REVIT, AutoCAD, OR CIVIL 3D)	DISCIPLINES (IF BIM)
					DISCIPLINES (IF BIM)
TAAs	Large Developments	ECC > \$10M	DTIG to evaluate project type and capabilities of team to determine BIM requirements	BIM As-Built delivered at project end	All disciplines for project
TAAs	Tenant Spaces and Buildings	\$1M < ECC < \$10M	DTIG to evaluate project type and capabilities of team to determine BIM requirements	BIM As-Built delivered at project end	ARCH, MEP, and STR
TAAs	Utilities and Runways	Before Jan 2016	AutoCAD/Civil 3D	30-60-100% and As-Built without attributes	Civil disciplines, Site, Utilities
TAAs	Utilities and Runways	After Jan 2016	Civil 3D with attributes at closeout	Civil 3D: - 30-60-100% and As-Built with attributes	Civil disciplines, Site, Utilities
HORIZONTAL PROJECTS	Including Garages and Bridges	\$1M < ECC < \$10M	New Construction	BIMxP managed by Design and Construction Teams	Major disciplines for project: ARCH, MEP, and STR., Civil model only if needed or required by MPA
HORIZONTAL PROJECTS	Including Garages and Bridges	\$1M < ECC < \$10M	Building Renovations	BIMxP managed by DTIG, clash detections managed by GC/CM	Major disciplines for project: ARCH, MEP, and STR., Civil model only if needed or required by MPA
HORIZONTAL PROJECTS	Including Garages and Bridges	\$1M < ECC < \$10M	Major Equipment	AutoCAD (no BIM) if A/E is standardized with BIM: No BIMxP Clash detections managed by GC/CM	Major disciplines for project: ARCH, MEP, and STR., Civil model only if needed or required by MPA
VERTICAL PROJECTS	Including Garages and Bridges	ECC < \$1M		AutoCAD (no BIM) if A/E is standardized with BIM: no BIMxP	BIM modeled ARCH, MEP, and STR., Civil model only if needed or required by MPA
VERTICAL PROJECTS	Including Garages and Bridges	ECC < \$1M		DTIG to evaluate project type and capabilities of team to determine BIM requirements	ARCH, MEP, and STR as agreed upon between DTIG and Team

FIGURE 1 (BIM DECISION MATRIX)

MPA BIM Projects

BIM will be used to develop high performing; well-coordinated designs that deliver desired project outcomes. It is required for new construction, substantial renovation, major maintenance and improvement, extension projects with a wide range of alternatives or significant financial impacts. Building and non-building projects with an estimated value of \$1 million and above should be reviewed for BIM use. The Project Manager is encouraged to consider BIM usefulness on all MPA projects. MPA developed the BIM Decision Matrix as a guide for BIM use on various MPA project types and sizes.



MPA Procurement Methods

MPA uses several project delivery methods, Commonwealth of MA, MGL Chapter 30,149,149A. For updated procurement options:

<https://www.massport.com/business-with-massport/capital-improvements>

The contracting method influences BIM sharing and communication. MPA does not utilize Integrated Project Delivery (IPD) contracts.

DESIGN-BID-BUILD

D-B-B is the traditional public bidding method, choosing a contractor based on lowest responsive bid after the completion of design. This remains the most common contractor selection method.

CONSTRUCTION MANAGER AT RISK (CONSTRUCTOR OR CM)

Constructor or CM@Risk is available for building projects over \$5M as authorized by MGL Ch. 149A. This allows Capital Programs to start design, select a qualified construction manager through a quality-based selection process, and negotiate a price prior to the completion of the design. Most of the costs associated with the work are based on competitive bidding. CM@Risk is only available for vertical projects over \$5M.

DESIGN-BUILD (DB)

Design-Build delivery method is available for horizontal (civil works) projects over \$5 Million. This method includes a two-part selection process to acquire one entity to design and construct the project. This first part is a quality-based shortlisting of qualified teams and the second step includes submissions from each team of both technical and price proposals followed by oral presentations. DB is only available on horizontal projects.

National BIM Standard, and Model Types

Definitions and terminology can challenge team communication. To assist team communication, MPA has selected industry terms for models used throughout the design, construction, and facility lifecycle.

Work in Progress (WIP) models are discipline models (structure, MEP) created by different team members for their specific area of expertise. These WIP models are reviewed and then federated¹ into the Design Intent Model.

The Design Intent Model is the federated (.rvt) model of all approved WIP models. This model is used for project BIM Use execution, digital design mock-ups, decision support, and clash avoidance. The construction documents are derived from the approved Design Intent Model. The approved model is a contract document for submission to MPA and for construction handover.

The Construction/Shop Models for fabrication are developed from the Design Intent Model during construction coordination. The files are typically combined using a cross platform 3D model viewing software to accommodate subcontractor file formats and the higher level of detailing. This new information is reviewed by the design team for approval.



The Record Model (.rvt) is a contract document submitted to MPA. The Record Model is the Design Intent Model updated to show the as-built locations of the elements within this model. The Record Model is the basis for FM handover and does not reflect all As-Built components' geometry. (Example: the Record Model will have the major elements of the MEP system, but may not show the hangers). The Record Model will contain accurate attribute data on major equipment and systems for FM documented in the BIMxP. The Record Model is typically updated by the Designer from information provided by the Constructor (digital mark-ups, photography, laser scans). It may be used by Commissioning or updated to reflect Commissioning data.

The As-Built Model (.nwd) is submitted to MPA by the Contractor. The As-Built Model is typically an Autodesk® Navisworks® file that includes shop models and drawing information from trades and fabricators with detail of the as-built conditions. This model may also include laser scan data. It is used as a detailed reference document of all as-built conditions, but is not the basis of FM.

¹ WIP MODELS (ARCHITECTURE, ELECTRICAL, STRUCTURAL, ETC.) ARE COMBINED OR FEDERATED IN THE PROJECT BIM COLLABORATION ENVIRONMENT.

THE NATIONAL BIM STANDARD

Photo © Robb Williamson / AECOM



"A Building Information Model (BIM) is a digital representation of physical and functional characteristics of a facility. As such it serves as a shared knowledge resource for information about a facility forming a reliable basis for decisions during its lifecycle from inception onward."

National Institute of Building Sciences

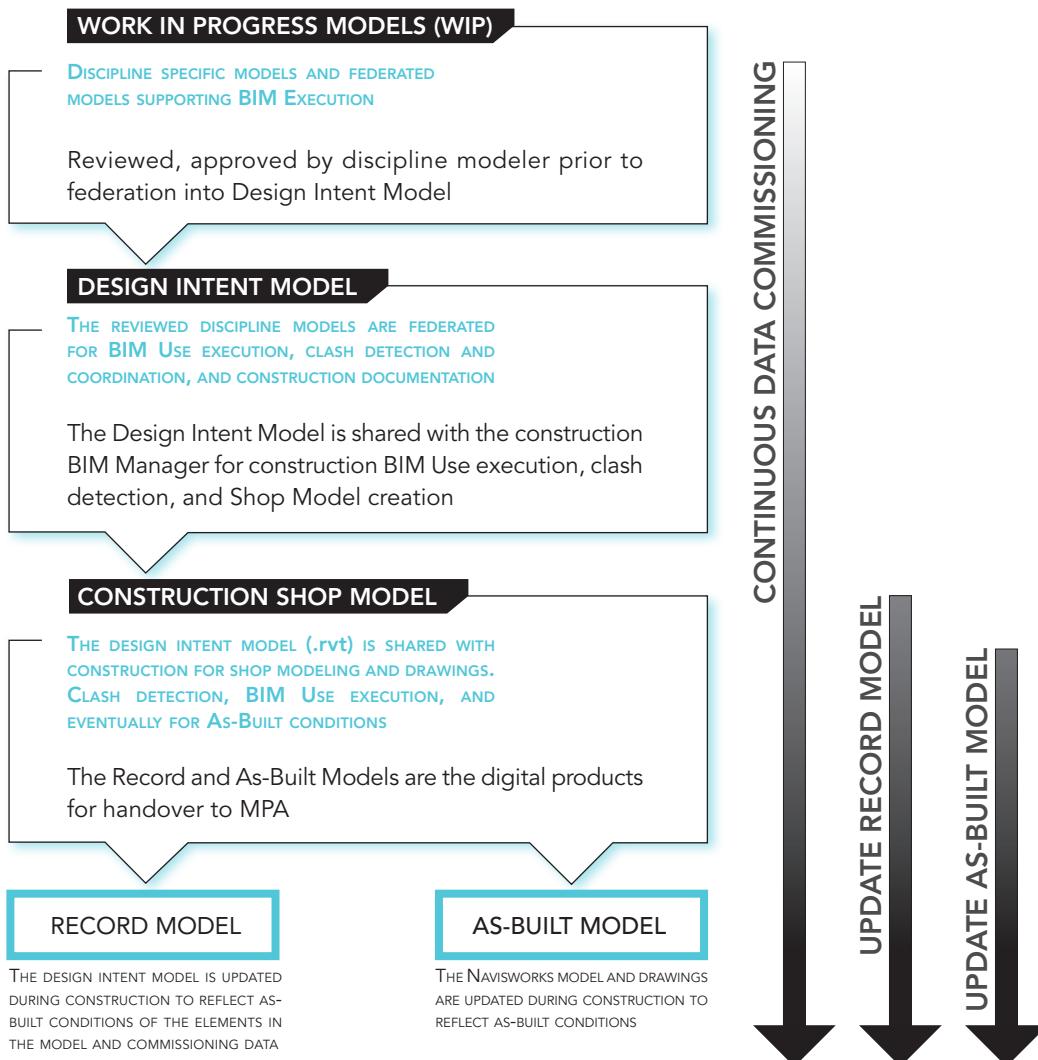


FIGURE 2 (BIM DURING THE PROJECT LIFECYCLE)

07



Photo © Robb Williamson / AECOM

MPA's decision to implement Building Information Modeling (BIM) represents a significant multi-year change in how MPA executes projects, develops information about its assets, and becomes a lean, virtual, and data-centric organization.

When used successfully, BIM offers higher quality design and construction projects, and standardized information for more informed decisions. The information is more coordinated, reliable and reusable, allowing MPA project teams to be more productive and the design solutions functional, cost effective, and sustainable. Facilities information, created during a BIM project, can be re-purposed, reducing costly information management redundancies for post construction operations.

BIM and Lean principles are equally essential enablers in MPA's strategy for innovative project delivery and lifecycle asset management. MPA expects BIM to be used within a Lean environment conducive to information flow, communication, analysis, and problem solving. Lean job sites promote safe, timely, and productive construction, and maximize information handover at project close.

1.1 | The MPA Facility Information Vision

ISO 55000 defines asset management as the coordinated activity of an organization to realize value from assets. Asset management achieves business objectives through asset-related decisions, plans, and actions within a strategic framework of processes, techniques, and tools. It seeks to optimize the cost, risk and performance of assets over their lifecycle at an individual asset, asset system, and asset portfolio level.²

MPA is responsible for sustaining the value and mission capability of its assets through innovative planning, design and construction activities, based on sound financial management, safe work practices, and respect for the environment.

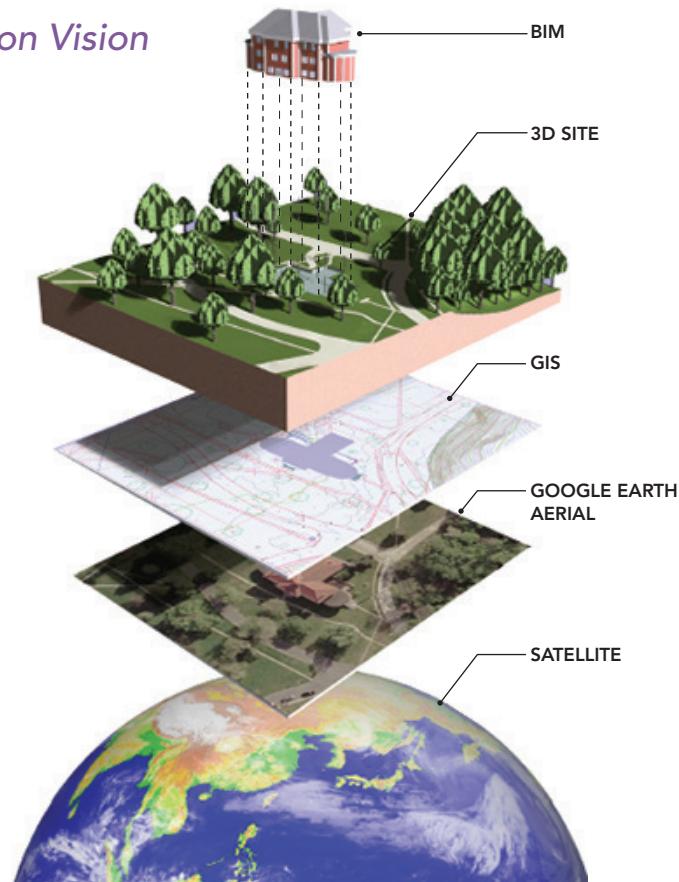
To achieve its mission, MPA's asset processes and decisions must be repeatable, fact-based, and verifiable across multiple asset types. Trusted asset data developed during projects in BIM is critical for reducing risk in operations, strategic planning, design, construction, sustainability, and environmental responsiveness. All these considerations make BIM a logical tool and process for MPA.

All of these benefits have made BIM the predominant tool and process for design by our service providers. MPA's move to BIM confirms its belief in the importance of this industry change and the benefits BIM will accrue to MPA.

This BIM Guide for Vertical and Horizontal Construction provides the vision and structure for MPA and its service providers, to develop successful BIM projects meeting MPA's mission.

THE MASSPORT MISSION STATEMENT

MPA owns and operates an integrated world-class transportation network that promotes economic growth and opportunity, enhances the quality of life of New England residents and protects the freedom to travel safely, securely, efficiently and cost-effectively. In meeting our responsibility to connect New England with the world, MPA strives to always be a good steward by treating colleagues and customers with respect, embracing diversity and minimizing the impact of transportation services on our neighbors and the environment.



1.1.1 | Strategy for an Owner BIM Portfolio

It is MPA's goal to have its facilities and major infrastructure assets digitally represented, including standard datasets, in an FM portfolio. To develop this inventory, MPA will use a multi-project, multi-year strategy of integrating Record/As-Built models to develop a complete asset model of larger facilities.

Models for existing facilities will come from several sources and project types. Assessment, survey and scanning to BIM activities, feasibility studies and planning, retro-commissioning, renovation, and sustainability projects can all have a BIM component.

The BIM data standards herein support the necessary model integrity and data consistency critical to this portfolio strategy. It is a goal for MPA to provide baseline models for projects, bidding activities, and handover to construction.

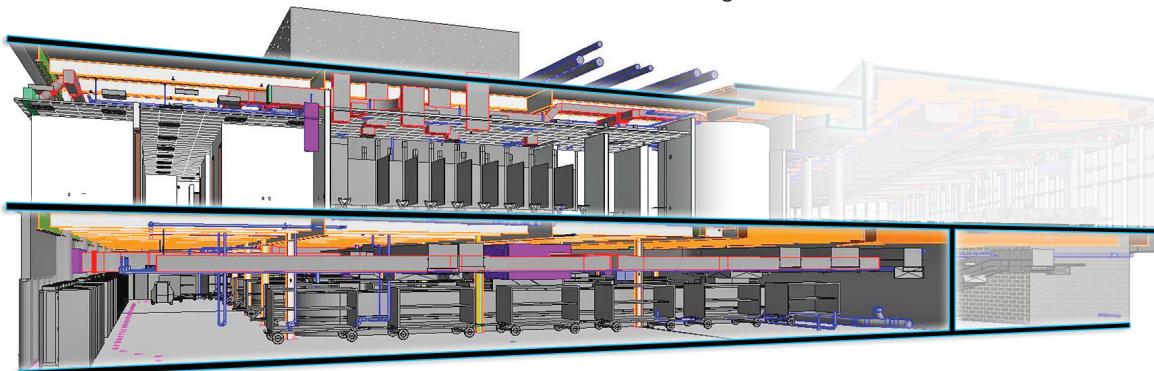


FIGURE 4 (MPA BIM, SECTION)

1.2 | BIM for Infrastructure and Horizontal Construction

MPA's portfolio includes land assets, airfields, marine facilities, utilities, horizontal structures, and other infrastructure, non-building assets. Infrastructure modeling emphasizes surface/sub-surface elements and topology supporting infrastructure projects.

While BIM has its best acceptance in vertical construction, the values of Lean and BIM also apply to infrastructure projects. MPA has already completed projects combining BIM, site and land use, and infrastructure modeling. BIM and GIS integration, Google Earth, Sketch-Up, Autodesk Infraworks®, and Civil 3D® are tool sets for "designing in place" models supporting MPA BIM on its facilities. Appendix A. has several infrastructure and site BIM uses.

Appendix A. BIM Uses includes horizontal, civil and site modeling BIM Uses:

- ▶ HORIZONTAL STRUCTURES BIM
- ▶ ROADWORK
- ▶ EXISTING SITE MODELING
- ▶ SITE DEVELOPMENT MODELING
- ▶ UTILITIES MODELING
- ▶ 4D SCHEDULING
- ▶ SITE SAFETY AND LOGISTICS

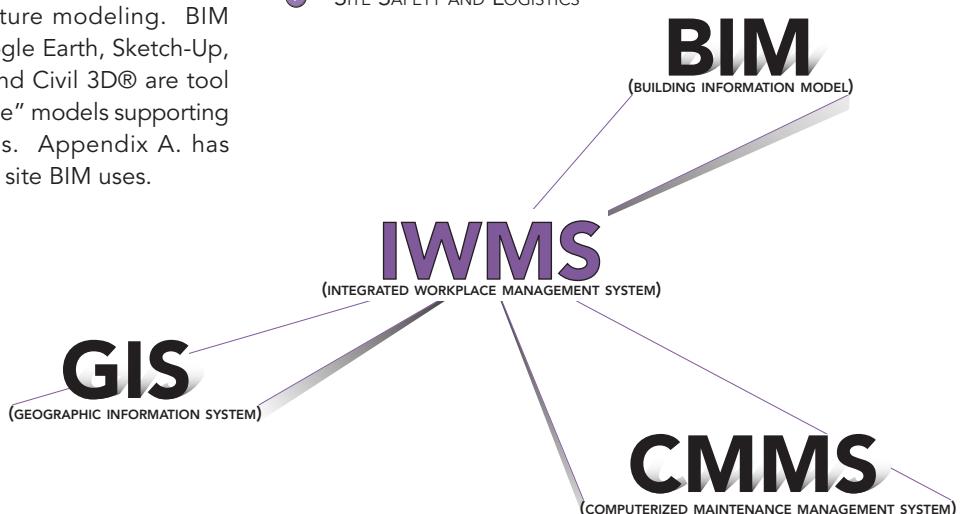


FIGURE 5 (DATA INFRASTRUCTURE)

1.3 | Integrated Enterprise Technologies

It is apparent that the lines drawn around traditional planning, design, BIM, GIS, and facilities management disciplines are proving to be arbitrary and self-limiting. Significant value is found where these disciplines overlap and multi-directional flows of information can occur. Current technologies begin to make this facility lifecycle flow feasible. This info-centric environment is supplanting transactional paper-centric activities with new digital workflows and communication.

BIM data, based upon open standards integrates with the Computerized Maintenance Management Systems (CMMS) and the Geographic Information Systems (GIS). This BIM, CMMS, and GIS infrastructure will hold the "ground truth" for MPA assets and provides dashboard data for a future Integrated Workplace Management System (IWMS) streamlining MPA's analysis, consideration, and prioritization of projects.

1.4 | The Design Technologies Integration Group (DTIG)

To maximize BIM and other emerging technologies, the MPA formed the Design Technologies Integration Group (DTIG), to implement the MPA BIM Roadmap, and operate as a single unified resource for CAD/BIM, CMMS, GIS, and future IWMS implementation. This group supports the technical data sharing, and application integration required for the MPA facility information infrastructure.

The DTIG Manager will work with the project team BIM Managers to develop Lean BIM project strategies, facilitate Value Stream Mapping³ for BIM Use development, monitor the BIM processes of the project teams, and insure that the BIM Guidelines are adhered to throughout design, construction, commissioning, handover, and closeout for the benefit of MPA projects.

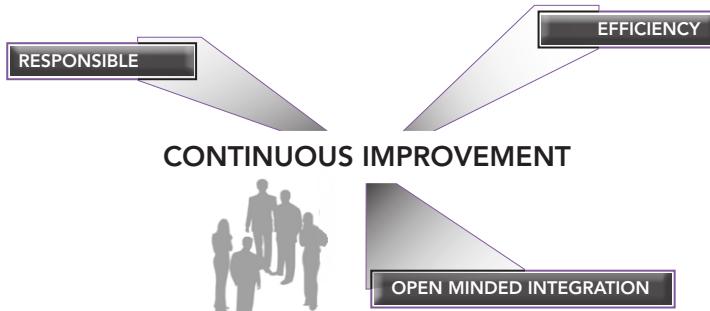


FIGURE 6 (DESIGN TECHNOLOGIES INTEGRATION GROUP)

1.4.1 | The DTIG BIM Manager Responsibilities:

The DTIG Manager has internal and project specific duties related to BIM use, technology integration and implementation within MPA. The manager will:

- ➊ HELP CREATE SPECIFIC BIM SCOPES OF WORK FOR PROJECTS;
- ➋ PROVIDE BIM PROJECT SUPPORT FOR MPA PROGRAMS;
- ➌ SUPPORT LEAN BIM;
- ➍ HELP PROJECT MANAGERS WITH BIM FACILITATION AND SKILLS;
- ➎ FACILITATE BIM EXECUTION PLAN (BIMxP) DEVELOPMENT ON PROJECTS;
- ➏ ENSURE COMPLIANCE WITH THE BIMxP TEMPLATE;
- ➐ FACILITATE THE MODEL PROGRESSION SCHEDULE SHOWING BIM USE AND ELEMENT LOD;
- ➑ REVIEW MODELS FOR QUALITY AND CONFORMITY TO THE MPA BIM STANDARDS AT HANDOVERS;
- ➒ COORDINATE BIM, CMMS, AND GIS INTEGRATION;
- ➓ MANAGE UPDATES TO MPA TECHNOLOGIES WITHIN THE MPA INFORMATION INFRASTRUCTURE; AND
- ➔ REVIEW EMERGING TECHNOLOGIES AND STANDARDS FOR INCORPORATION INTO MPA'S BIM PROGRAM.

³ VALUE STREAM MAPPING- VALUE STREAM MAPPING IS A LEAN METHODOLOGY TO IDENTIFY WHAT HAS VALUE FOR A PROJECT.





The efforts to standardize team collaboration, automate modeling processes, and utilize data standards remain fragmented across standards groups, process silos, competing software vendors, and industry organizations. Currently, the AEC industry does not have a culture which focuses on facility lifecycle and well-understood collaboration and data standards to support current technology capabilities. As an owner, MPA is forced to bring together several disparate industry initiatives in this guide to gain BIM efficiencies on projects.

Lean principles⁴, BIM Uses, the National BIM Standard (NBIMS), National CAD Standards, CSI's OmniClass, Level of Development (LOD)⁵, and BuildingSMART Alliance (BSa) open data standards are essential enablers of MPA's strategy for innovative project teaming, virtual design and construction⁶ (VDC), and BIM data management supporting its facility lifecycle information vision. MPA expects project teams to understand these concepts and utilize them on MPA BIM projects.



FIGURE 7 (INDUSTRY ORGANIZATIONS SUPPORTING BIM AND LEAN)

⁴ LEAN INSTITUTE AND LEAN CONSTRUCTION INSTITUTE

⁵ LEVEL OF DEVELOPMENT – FIRST APPLIED BY GRAPHISOFT, VICO AND ADOPTED AS AN INDUSTRY BEST PRACTICE BY NBIMS, AND STANDARDIZED BY AGC 2014.

⁶ THE TERM 'LEAN CONSTRUCTION' IS AN ADAPTATION OF LEAN PRODUCTION TECHNIQUES AS APPLIED TO THE CONSTRUCTION INDUSTRY.

2.1 | Lean Principles for Design and Construction

The Consultant will use Lean Design and Construction approaches and tools to work collaboratively with MPA. Lean and BIM will be used to design and construct the project in the most efficient manner possible to meet all of MPA's Conditions of Satisfaction (CoS) for the Project. As Christian Pikel explains in his Lean Project Delivery Guide, Conditions of Satisfaction are "Measurable statements that tell the project delivery team what tests a project must pass to be accepted as a success." The intent is that MPA, the Consultant, and other key stakeholders will work in an integrated and collaborative manner within the existing statutory and contractual frameworks.

Lean Design and Construction applies specific management tools to achieve the objectives of a Lean production system – delivering exactly what the customer wants while maximizing value and minimizing waste. MPA anticipates that it will use Lean approaches and tools such as a "Big Room" for the design and construction phases; "Target Value Design" processes for the design phase; and Last Planner® System production planning for the design and construction phases. MPA may use other Lean approaches and tools, including but not limited to, A3 and "Choosing by Advantages" decision making processes.

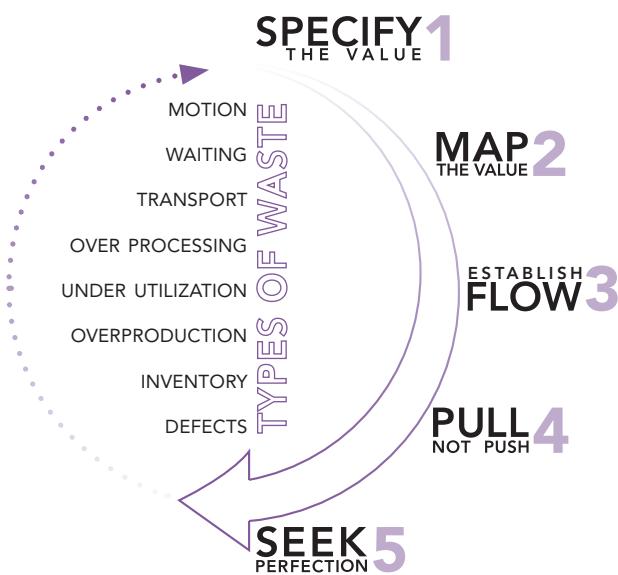


FIGURE 8 (5 LEAN PRINCIPLES AND 8 FORMS OF WASTE)

- **SPECIFY "VALUE"** - According to what the customer wants and is willing to pay for. Over-modeling is wasteful, while under-modeling affects model support for project options, analysis, decisions and schedule. Data standards support analysis for project problem solving and maximize model value at project handover.
- **MAP THE VALUE** - Map activities that deliver the highest value using the least amount of resources. BIM can be streamlined by identifying its "value stream" – in Lean terminology, define WHAT is modeled, WHEN, and for WHAT purpose. This information is considered a BIM Use. MPA has identified numerous BIM Uses⁸ of value. The processes mapped by the team should deliver on the "Conditions of Satisfaction", provide useful information in the shortest time and in the form supporting informed decisions at that stage of the project. Value Stream Mapping (VSM)⁹ helps eliminate any steps in the BIM Use that do not add value and allows a team to be innovative in how BIM is developed.
- **ESTABLISH FLOW** – BIM is a primary means of developing project information. Project flow can be accomplished by aligning BIM Use execution to team process mapping. This allows the BIM Managers to transition from one value-adding BIM Use to the next supporting project development and information flow. This model progression is identified in the BIMxP.

It is in the best interest of all parties to hold regularly scheduled meetings for model development and review. Models typically help teams identify issues earlier in the design process. The models can minimize misinterpretations and support team problem solving and project execution.

⁷ CONDITIONS OF SATISFACTION (CoS) - LEAN TERMINOLOGY FOR PROJECT OBJECTIVES, THAT IS, WHAT IS OF VALUE TO THE CUSTOMER?

⁸ APPENDIX A – BIM USES

⁹ VALUE STREAM MAPPING – LEAN TERM FOR PULL PLANNING GOALS AND ACTIONS WITHIN THE PROJECT

MPA allows the traditional 30% - 60% drawing submissions to be model based for review if documented in the BIMxP. The project team will use Lean tools to map project value, and develop BIM information supporting the decisions to be made at these early milestones. BIM Use execution determines BIM production for these milestones. This is documented in the BIMxP Model Progression Worksheet.

- “**PULL, DON’T PUSH.**” - This principle of Lean design suggests starting with the project goal or outcome and “pulling” toward it, performing only the work needed to accomplish the goal. Accomplishing this requires planning step-by-step backward from the goal to determine what each step in the process requires from the one before it. Later steps determine what the earlier steps should be and when they should occur. Nothing should be done that is not required by a later step in the process.
- **PURSUE “PERFECTION”**- through continuous improvement. PLAN, DO, CHECK, ACT is the methodology for improvement. Relentless examination of each project identifies bottlenecks and their causes and ways to eliminate activities on subsequent projects. Do not be constrained by serialized process relationships. Look for processes that can be performed in parallel, automated or eliminated in order to increase the net quality, and reduce the net time to outcome.



FIGURE 9 (LEAN PULL PLANNING ACTIVITY, TERMINAL B LOGAN AIRPORT)

PLAN - Use the BIM Execution Plan and Value Stream Project Mapping and Pull Planning to identify the BIM Uses that meet the project Conditions of Satisfaction

DO - Train and support the project BIM team in well understood BIM processes and collaboration procedures. Understanding WHAT is needed WHEN, will reduce breaks in information flow.

CHECK - Model progression through periodic project team meetings in person or virtual. Use the model to support problem solving, explanations for decision support.

ACT - The BIM Manager will conduct project BIM workshops at project initiation, model progression reviews, BIMxP updates throughout the project, and BIM Use execution by phases.

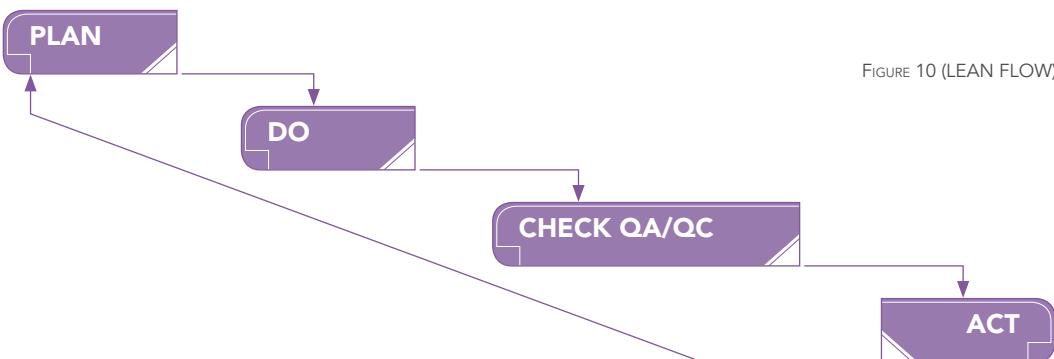


FIGURE 10 (LEAN FLOW)

LAST PLANNER™ SYSTEM®¹⁰ - To manage the delivery process and improve team effectiveness with good planning and communication. The BIM development cycle is a supporting swim lane to the overall project execution activities.

The five elements of the last planner system include:

- ➊ Master Scheduling (setting milestones and strategy; identification of long lead items);
- ➋ Phase "Pull" planning (specify handoffs; identify operational conflicts);
- ➌ Make Work Ready Planning (look ahead planning to ensure that work is made ready for installation; re-planning as necessary);
- ➍ Weekly Work Planning (commitments to perform work in a certain manner and a certain sequence); and
- ➎ Learning (measuring percent of plan complete (PPC), deep dive into reasons for failure, developing and implementing lessons learned).¹¹

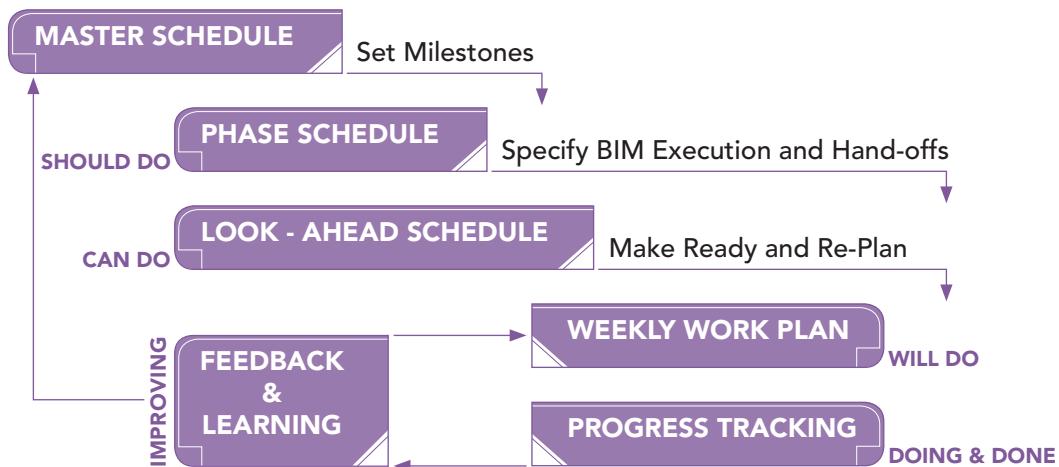


FIGURE 11 (LAST PLANNER DIAGRAM)



Image © Parsons Brinckerhoff // ConRAC

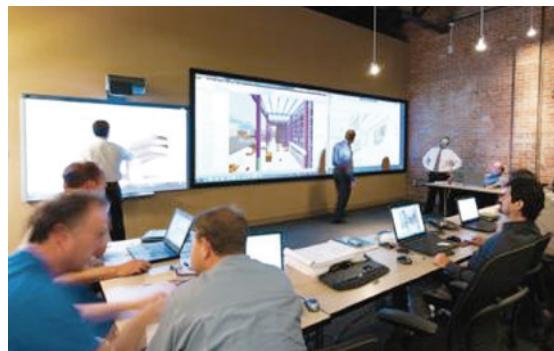
¹⁰ GLENN BALLARD AND GREG HOWELL, LEAN CONSTRUCTION INSTITUTE, CREATED THE LAST PLANNER² SYSTEM (LPS) TO IMPROVE THE PREDICTABILITY AND RELIABILITY OF CONSTRUCTION PRODUCTION. (SEE [HTTP://WWW.LEANCONSTRUCTION.ORG](http://WWW.LEANCONSTRUCTION.ORG))

¹¹ LEAN CONSTRUCTION INSTITUTE (LCI) [HTTP://WWW.LEANCONSTRUCTION.ORG/TRAINING/THE-LAST-PLANNER](http://WWW.LEANCONSTRUCTION.ORG/TRAINING/THE-LAST-PLANNER)

2.2 | Importance of the BIM Uses – “Start with Why”

A BIM Use defines a modeling activity that adds value to the project. It defines WHY to model, WHAT to model, WHO is responsible, the typical LOD, the outcome and the deliverables. When a BIM Use is executed is determined by WHAT information is needed WHEN and by WHOM, to support informed project decisions and flow.

Defining WHAT BIM Uses are executed WHEN is part of the project pull plan and produces the right information in a cost effective and timely manner.



These BIM Uses represent MPA’s understanding and desired outcomes for BIM use on projects. The BIM Use description represents a “point of departure” for a BIM Use. The team should consider this a minimum activity and offer innovations in keeping with industry advancement. (Appendix A.)

OmniClass Table 31 Phases

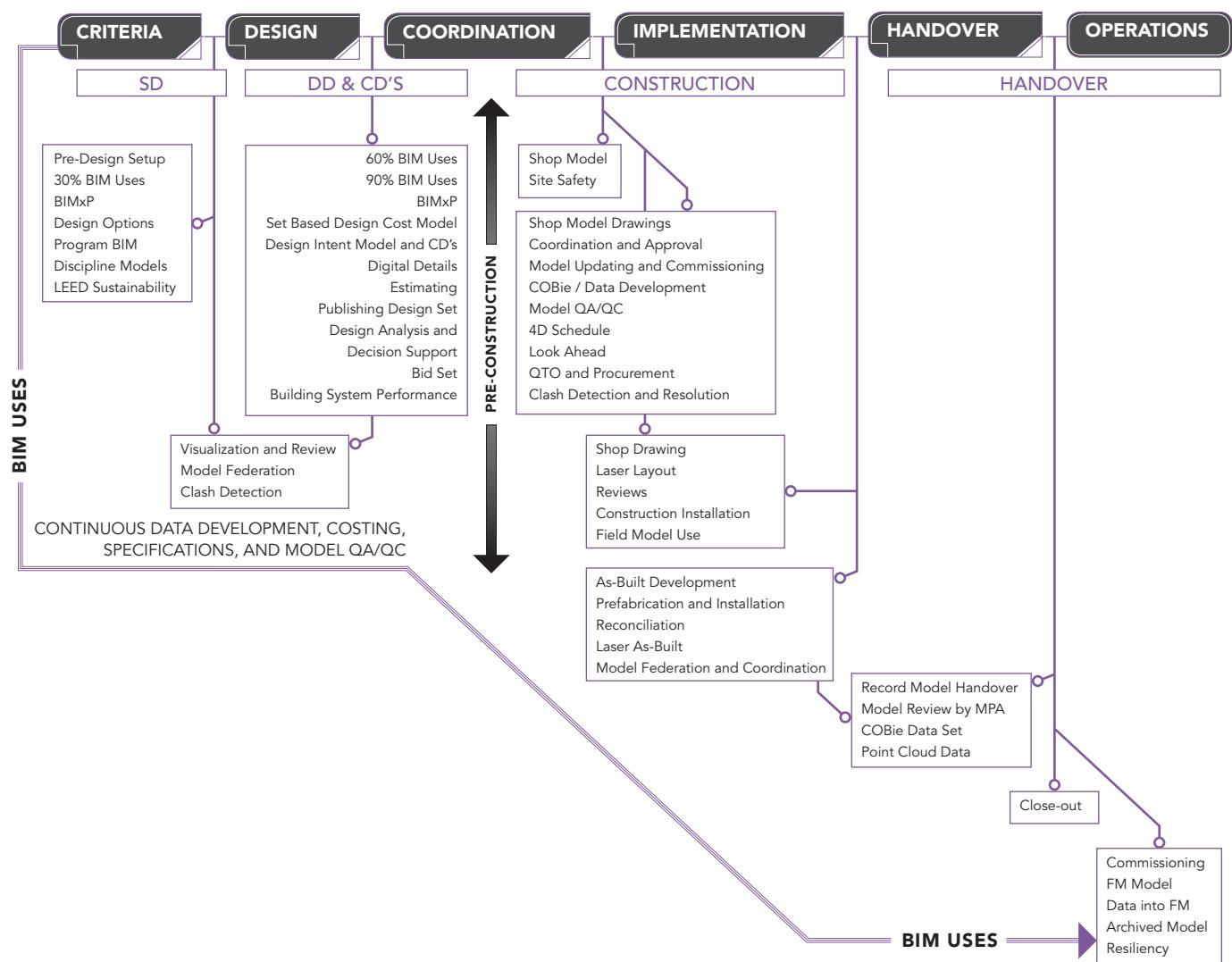


FIGURE 12 (BIM USE MAPPING SHOWING OMNICLASS PHASES AND TRADITIONAL PHASES FOR PROJECT PROGRESSION)

2.3 | Model Level of Development (LOD)

The AIA/AGC Level of Development (LOD) Specification published in 2014 is incorporated as a reference in MPA BIM projects.

Level of Development (LOD) has evolved to convey BIM geometry complexity and data¹² reliability. It helps project teams and owners define BIM modeling effort and requirements in a BIM Use or a final deliverable. BIM managers use LOD to explain information reliability needed at various points in model development.

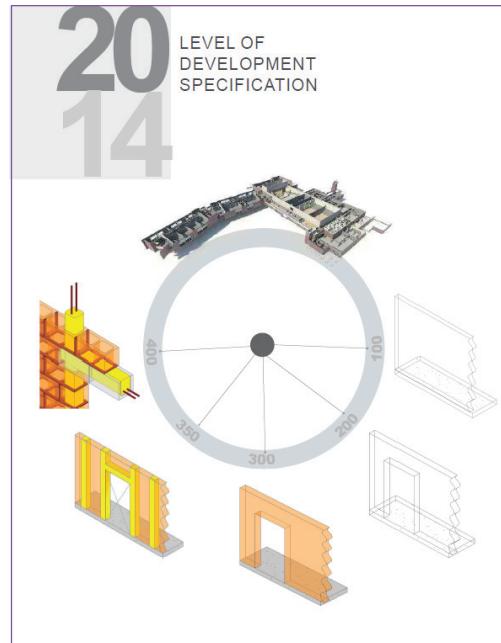


FIGURE 12 (AGC LOD SPECIFICATION)



100

The Model Element may be graphically represented in the Model with a symbol or other generic representation. Information related to the Model Element (i.e. cost per square foot, tonnage of HVAC, etc.) can be derived from other Model Elements.



200

The Model Element is graphically represented within the Model as a generic system, object, or assembly with approximate quantities, size, shape, location, and orientation. Non-graphic information may also be attached to the Model Element.



300

The Model Element is graphically represented within the Model as a specific system, object or assembly in terms of quantity, size, shape, location, and orientation. Non-graphic information may also be attached to the Model Element.



350

The Model Element is graphically represented within the Model as a specific system, object or assembly in terms of size, shape, location, quantity, and interfaces with other building systems. Non-graphic information may also be attached to the Model Element.



400

The Model Element is graphically represented within the Model as a specific system, object or assembly in terms of size, shape, location, quantity, and orientation with detailing, fabrication, assembly, and installation information. Non-graphic information may also be attached to the Model Element.



500

The Model Element is a field verified representation in terms of size, shape, location, quantity, and orientation. Non-graphic information may also be attached to the Model Elements.

FIGURE 13 (LOD DEFINITIONS)

¹² [HTTPS://BIMFORUM.ORG/LOD/](https://bimforum.org/LOD/)

MPA IS USING LOD TO:

- Utilize a standard that can be referenced by contracts and in the BIMxP
- Define model effort and requirements in a BIM Use
- Be a reporting mechanism in the project BIMxP for model and data progression.
- Communicate model development and information reliability. LOD is not uniform for all models and all elements through the project phases. Rather LOD is related to the BIM Uses and objects/elements used in the project.

NOT USED IN THE GUIDE:

- Level of Detail (LoD) addresses the geometric detail of objects, from a simple bounding box to a product specific representation. MPA has not used LoD in this BIM Guide.
- Grades from the UK¹³ provides for the difference in data reliability and geometry. An object may have a simple geometric representation with highly reliable data. Data grades are under review for MPA and a firm using grades may review this use for approval on MPA projects.

2.3.1 | Object Element Attribute Data Reliability

The prime BIM Manager and the MPA DTIG Manager will work together to define the needed LOD per project requirements, and to remove any ambiguity in LOD definition for the project. These issues can be raised during the BIMxP development.

- Data attributes at LOD 200 are generic and suitable for early performance analysis and design options

- LOD 300 is suitable for performance requirements, estimating and procurement. Bid Documents are generally LOD 300
- LOD 350 is product specific
- LOD 400 at project turnover defines the information on the installed product or building element.

2.4 | Industry Data Standards

Many BIM, CMMS, and CAFM software vendors are incorporating industry standards into their software. MPA utilizes these national standards to streamline data integration, increasing the value of the data and maximizing the sharing and re-use for design and construction and the asset lifecycle.

These industry initiatives and standards form the infrastructure and collaboration strategy for MPA projects. How they are used on a project is documented in the BIM Execution Plan.

- **The National BIM Standard (NBIMS)**¹⁴ - is an open source standard for BIM. Major products of NBIMS are the Information Exchanges (ie), which define a purpose, components, and attributes for BIM development. Industry Foundation Classes, (IFC)¹⁵ are documented in NBIMS information exchanges.
- **National CAD Standard (NCS)** - NBIMS is incorporating the National CAD Standards with BIM to support drawing production and publishing of construction documents. MPA will review and update its Drawing and Publishing Requirements as necessary.
- **The OmniClass Standard** - is a faceted building information classification system made up of interrelated tables that define the built environment. MPA currently uses UniFormat and MasterFormat in its projects. These are being integrated into OmniClass. As part of the move to BIM, MPA is transitioning to OmniClass™ Construction Classification System (OCCS)¹⁶ Table 13 for space classification in the BIM Execution Plan Template.
- **UniFormat and MasterFormat** - These standards are still in use in the BIMxP and are acceptable data classifications. The use of UniFormat and OmniClass will be defined in the BIMxP for the project.

¹³ AECUK.FILES.WORDPRESS.COM/2012/09/AECUKBIMPROTOCOL-V2-0.PDF

¹⁴ NATIONAL INSTITUTE OF BUILDING SCIENCES, NIBS WWW.NATIONALBIMSTANDARD.ORG

¹⁵ IFC – AN OPEN NON-PROPRIETARY EXCHANGE FOR BIM

¹⁶ ALL OMNICLASS TABLES, AND EDUCATION OPTIONS ARE AVAILABLE AT: WWW.OMNICLASS.ORG

3

| Lean and BIM Integration

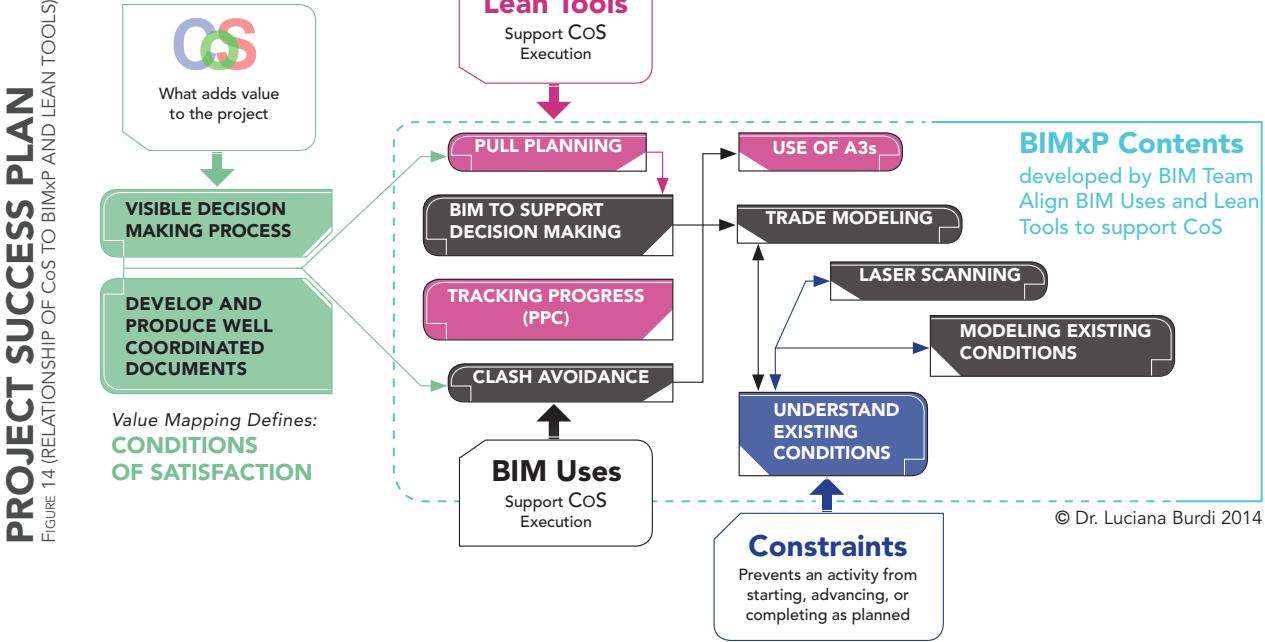
Lean and BIM are separate industry initiatives brought together as mutual enablers of MPA's project management and delivery system. Lean and BIM will be used in all phases of the project lifecycle. On each phase of the project, there is a BIM Manager role (Designer and Constructor) usually filled by a different person or company. It is the Lean approach and tools that make these different groups into a unified project team capable of BIM collaboration across the project lifecycle. This Lean and BIM integration for project success is managed by the MPA Project Manager and the DTIG Manager throughout the project lifecycle.

● Role of the MPA Project Manager:

The MPA Project Manager (MPA PM) has the responsibility to lead the development of the project team's Lean collaboration strategy and then oversee the execution of that strategy, including BIM use as needed to meet the projects CoS.

The MPA PM will coordinate with the MPA DTIG Manager and the Prime BIM Manager on BIM use requirements for the project. The aligned BIM Uses supporting the CoS will be documented in the BIMxP. The MPA PM and DTIG Manager will periodically review the BIMxP for compliance.

The MPA PM will be responsible for ensuring that the Constructor BIM Manager is on-boarded to the project team when the Constructor is selected and that, at the appropriate juncture, the lead for managing the BIMxP is transitioned from the Design BIM Manager to the Constructor BIM Manager.



- One of MPA's goals is to standardize project execution, BIM production, and submissions across all projects. However, design and construction teams bring different understandings of how BIM projects are managed and executed.

For teams to arrive at a unified strategy with effective collaboration, and efficient BIM production, MPA recognized that its contract and manuals, project structure, and the role and skills of the MPA PM and service providers needed to change. The MPA PM would begin to facilitate the use of Lean and BIM on projects.

By standardizing on Lean Design and Construction approaches and tools, MPA is adopting a repeatable project management system that works within the various MPA project procurement and project delivery options. As an industry initiative, Lean training, approaches, tools, and facilitators are commercially available, and resources continue to expand as universities teach Lean strategies to graduating students.

3.1 | The MPA Lean BIM Environment

MPA will use and implement a Project Success Plan approach to integrate Lean and BIM. This will make BIM production directly responsive to the design decision process, thereby reducing waste in the project delivery process.

By utilizing BIM to support project CoS and Lean activities, MPA has moved forward on its goal for a standardized project management environment with the "end always in mind".



3.1.1 | Project Kick-Off - Conditions of Satisfaction Session

CoS are high level measures of project success and should not be confused with program/project requirements which are the details of the project.

Within 30 days from Designer contract award, the prime design team and MPA PM and Design BIM Manager will schedule the kick-off session to develop and gain agreement on the project CoS. The project team and stakeholders will participate in the kick-off session. More specifically, BIM Managers and discipline BIM Coordinators will attend the kick-off meeting in order to understand the CoS for development of a BIMxP that supports the project. A Lean facilitator is recommended to facilitate the session.



FIGURE 15 (LEAN PULL PLANNING)

3.1.2 | BIM Uses and CoS

MPA has identified numerous BIM Uses (Appendix A of the BIM Guide) for MPA projects. These definitions and requirements are used as a starting point to define BIM project execution.

Many project CoS utilize BIM information. After the CoS are defined and agreed to by the project team and stakeholders, the Design BIM Manager will align BIM Uses to the CoS and project/program requirements. The implementation strategy and how BIM will be used by the project team is documented in the BIMxP.

3.1.3 | Constraints

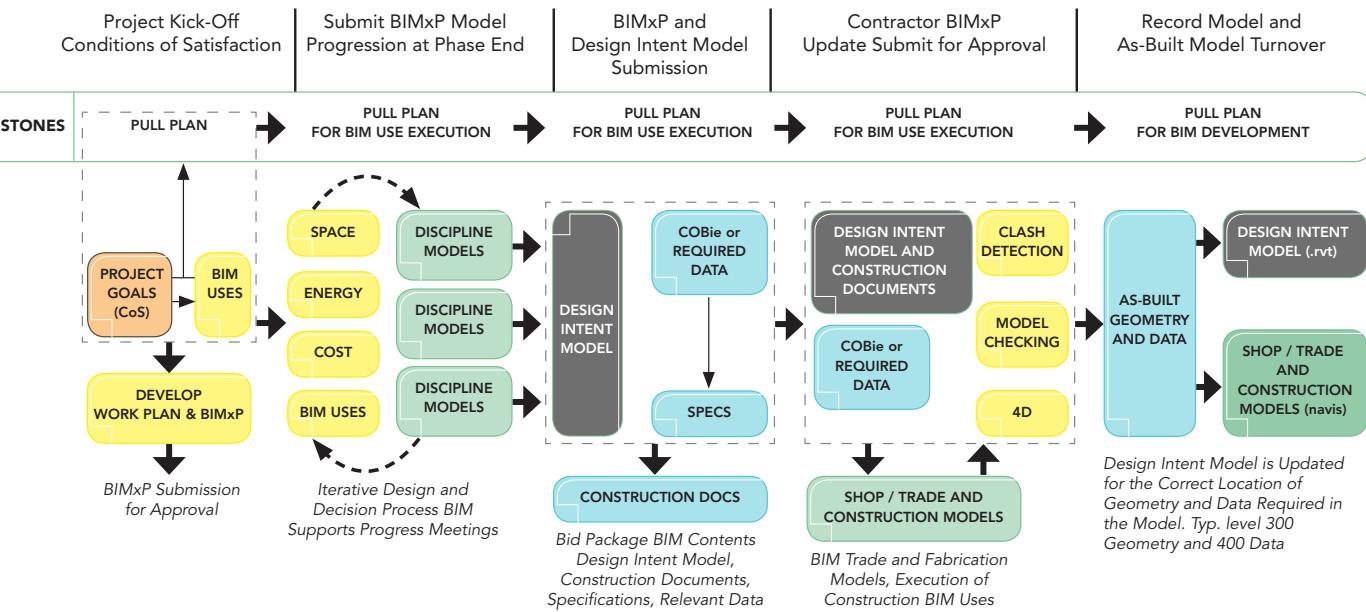
A constraint is an item or requirement that will prevent an activity from starting, advancing or completing as planned. "Something that stands in the way of a task being executable".

Development of the CoS will also include identification of any constraints to be removed or mitigated to achieve the CoS - any of those constraints that can be removed or mitigated by BIM uses will be included in the BIMxP. Constraints may also be resolved by the use of the A3 decision making process or in the course of regular progress meetings.

3.1.4 | Lean Tools

As noted above, project teams may decide to use various Lean tools such as a Target Value Delivery that can include: a "Big Room" approach to team collaboration; a focus group organization; Set-based design options; decision making tools such as A3s and Choosing by Advantages; and Last Planner® System pull planning. The BIM Manager will be asked to recommend to the team where BIM uses can support each of these tools. For example, the BIM Manager may be brought into focus groups when BIM can be useful in resolving a design issue. This could include a "digital mock-up" or model federation for Target Value Design or visual decision support.

As another example, a BIM swim lane will be added to the project pull plan showing how BIM will be used to support specific project deliverable milestones and focus group design decisions.



The above diagram shows the BIM collaboration and handover environment based upon the CoS. Each step identifies the information to be documented in the BIMxP.

3.1.4 | Handover Meeting – Design to Construction

Depending upon the contracting method, MPA will furnish the design intent model and the Design BIMxP to the constructor team. Separate of the Construction Project Kick-Off Meeting, a meeting will be scheduled between the architect BIM Manager, the DTIG Manager, and the Constructor BIM Manager to review the model content and structure as part of the handover process.

The Constructor BIM Manager may also provide BIM RFI requests during the initial phase of coordination and during the regularly scheduled clash detection reviews. The teams will work together to resolve any conflicts in the model, and throughout the shop modeling and review phase. The Design Architect and BIM Manager will review the shop model content for adherence to design intent and specifications.

To facilitate efficient communication, the teams will process map any coordination procedures new to the teams. This includes shop model development and review, and Record Model coordination and development.

4 | The BIM Execution Plan (BIMxP)

The BIMxP is a project contract document. It is the primary means of documenting the unified team strategy for BIM collaboration and development. The BIMxP:

- Establishes a basis for better communication between BIM parties, and a schedule for BIM development;
- Determines possible adjustments to the BIM Guide to support the specific project. MPA must approve any adjustments;
- Documents project infrastructure, (software, hardware, server) suppliers, and hosts BIM;
- Documents BIM roles and responsibilities to the appropriate team or team member and communicates expectations to all team members and project stakeholders;
- Documents the Meeting Schedule for the BIM Manager and BIM Discipline Coordinators – This sub-group shall develop the project template using MPA coordinates, project phasing, model organization, multi-user access, and model/sub-model ownership;
- Documents a checking and validation process and schedule for BIM review;
- Identifies the process flow for BIM Use execution, and shows the connection to project milestones, model submissions, model progression and LOD. Lean Pull Planning and Value Stream Mapping will facilitate this activity.¹⁷
- Defines information exchanges, shared access, and model federation;
- Documents model access and security protocols;
- Documents model integrity and data safety plan;
- Establishes measurable goals for BIM success and team execution. This will become part of the project lessons learned, and may be incorporated into subsequent BIM Guide updates.

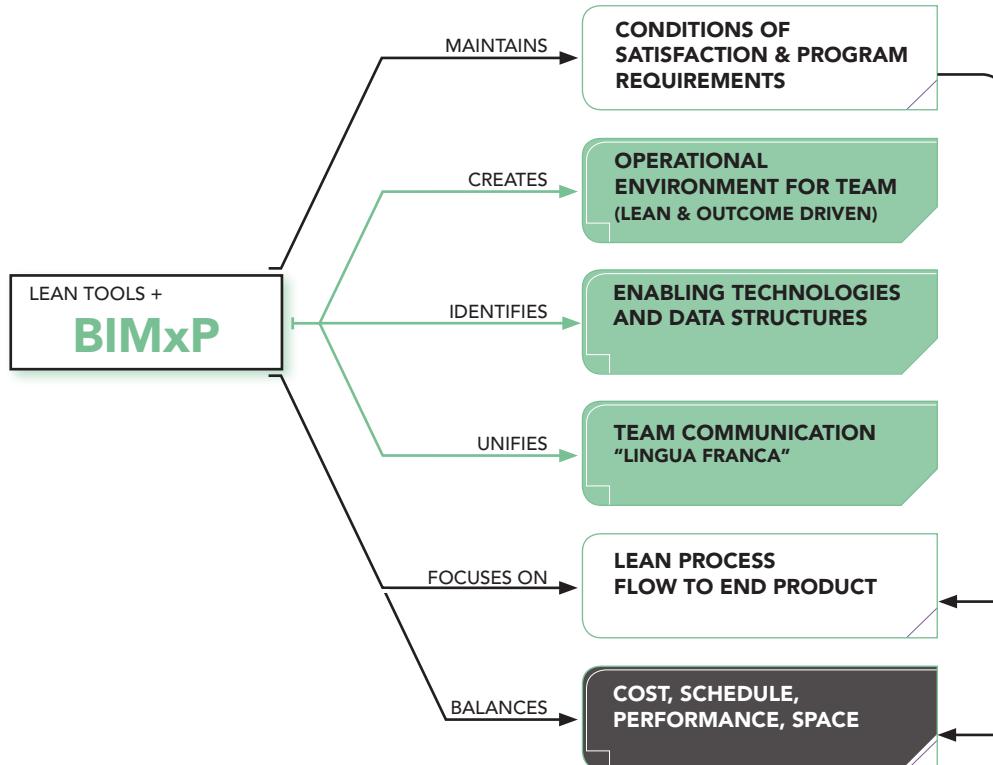


FIGURE 17 (BIMxP VALUE)

¹⁷ LEAN CONSTRUCTION INSTITUTE

4.1 | BIM Execution Plan Template

The MPA BIMxP template is used in the development of the project BIMxP by defining Data Standards, Project Information: including contacts, project location, and schedule. The template provides strategic and technical procedures for BIM collaboration, model sharing and infrastructure. The template documents several project Conditions of Satisfaction (CoS), and provides a means of aligning BIM Uses to these and other project goals. Lastly, the BIMxP template outlines the execution of BIM Uses throughout the project, identifying responsible parties and model development goals throughout each phase.

Introduction and Data Standards – This heading includes project standards, definitions and abbreviations used in projects and the pull down menus in the BIMxP.



Photo © Robb Williamson / AECOM

CATEGORIES CONDITIONS OF SATISFACTION	CoS No.	PRIORITY	ACTIONS SUPPORTING THE CONDITIONS OF SATISFACTION	OWNER	A/E	CONSULTANT	CONTRACTOR	SUB-CONTRACTOR
Collect and use accurate information supporting project start, design options, and processes.	1.1		Project Site Modeling - Also Infrastructure					
	1.2		Model the context for the project (project area surrounding project site)					
	1.3		Utilize scanning technology to develop existing conditions model					
	1.4		Capture accurate building interiors modeled to an LOD required for project					
	1.5		Identify and document environmental site conditions					
	1.6		Model campus or multi-building facility for Master Planning					

FIGURE 18 (BIMxP CONDITIONS OF SATISFACTION SECTION 3)

SECTION 4 BIM USE					
CoS Priority	Final BIM Use	BIM Use No.	BIM Use Name	BIM Use General Description	GENERAL LOD
			1	EXISTING CONDITIONS	
2	1.1	Project Site Modeling - Also Infrastructure		The project site modeled to an LOD 200 geometry showing topography, relevant surfaces, access, site utilities, major plantings to be protected, historically significant or environmentally sensitive areas.	
		1.2	Surrounding Site Modeling	Provides additional land modeling or imagery providing the larger context for the project site. May be used with existing site conditions model and Existing Building Models. Also used for Wayfinding and Traffic pattern modeling.	
1	1.3	Laser Scanning Existing Conditions		Laser scanning for building exterior or interior (project scope dependent). Laser scanning post processed into a BIM or hybrid file - BIM with point cloud as reference - Data determined by SOW.	
3	1.4	Existing Conditions - Building Interior		Existing buildings may be simple massing, blocking / stacking models, photometric models, or laser scan accurate BIMs per MPA and project needs. Existing buildings carry meta-data (Building Name, Bldg. Number, Current Use, Built Date, Occupancy State, Square Footage, Est. Value-Condition Metrics - TBD)	

FIGURE 19 (BIM USE MATRIX)

¹⁸ [HTTP://WWW.OMNICLASS.ORG](http://www.omniclass.org)

4.1.1 | BIMxP Management and Updates

The BIMxP will stay current with BIM Use execution, LOD development, new stakeholders' contributions, meeting schedules or new tasks. The BIM Manager (design or constructor) will be responsible for BIMxP updates. MPA will review the BIM execution and LOD development at the BIM milestone reviews (Section 5. Model Progression). The BIMxP should be reviewed and updated at the start of each project phase and regularly during construction.

Any issues or discrepancies in BIM Use execution, modeling requirements and structure should be brought to the attention of MPA and resolved in the BIMxP for the project.

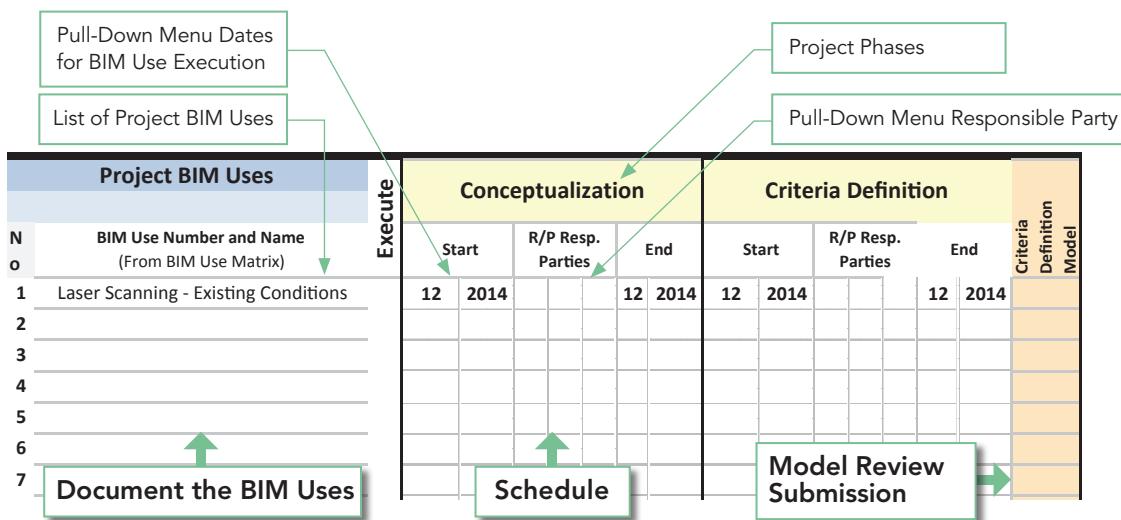


FIGURE 20 (MODEL PROGRESSION UPPER SECTION)

4.2 | BIM Roles and Responsibilities

The design BIM Manager, the consultants, the constructor BIM Manager, the trades and fabricators, may all develop, manage, or use BIM during a project. Therefore, all teams shall have the appropriate level of BIM expertise to execute their respective project scopes of work (SOW).

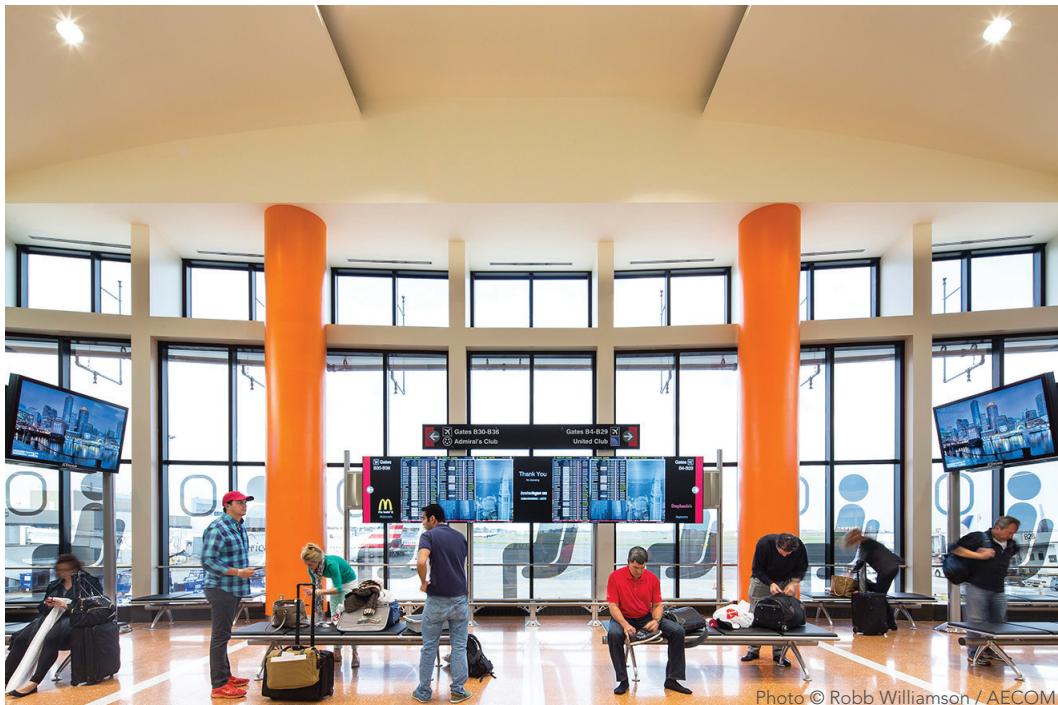


Photo © Robb Williamson / AECOM

4.2.1 | The Prime Design BIM Manager's Role

The Design BIM Manager provides BIM direction, continuity, quality control, per the BIMxP. This BIM Manager's responsibilities include the following:

- Reports directly to the project architect;
- Documents all software and versions in the BIMxP, and maintains version control;
- Oversees development, coordination, verification, and publication of all model configurations for BIM execution, and supports seamless integration of the discipline models and data;
- Ensures software is installed, operating properly, and is version-synchronized for ease of data and design documentation transfer within the teams and to MPA;¹⁹
- The Prime Design BIM Manager provides a "Big Room" specification for approval during design phases. Facilitates design coordination and clash detection of integrated discipline models and the design intent model for meetings. Also provides clash detection reports, and reports the resolution of all hard and soft collisions;
- Ensures that BIMs are used appropriately to test design requirements and criteria for functionality;
- Assumes responsibility for the proper classification of all spaces and equipment in the model to ensure program compliance and data standards conformance for downstream use including facility management;
- Determines the project BIM geo-reference point(s), and assures all technical discipline models are properly referenced;²⁰
- Ensures that the design deliverables specified in the contract are provided in accordance with the formats specified at design coordination and project handover;
- Ensures proper BIM-derived 2D information for paper printing or publishing that conforms to NCS²¹ and MPA requirements, and ensures construction documents are produced from a fully coordinated design intent model;
- Ensures the transfer of management responsibilities including, but not limited to those described herein.

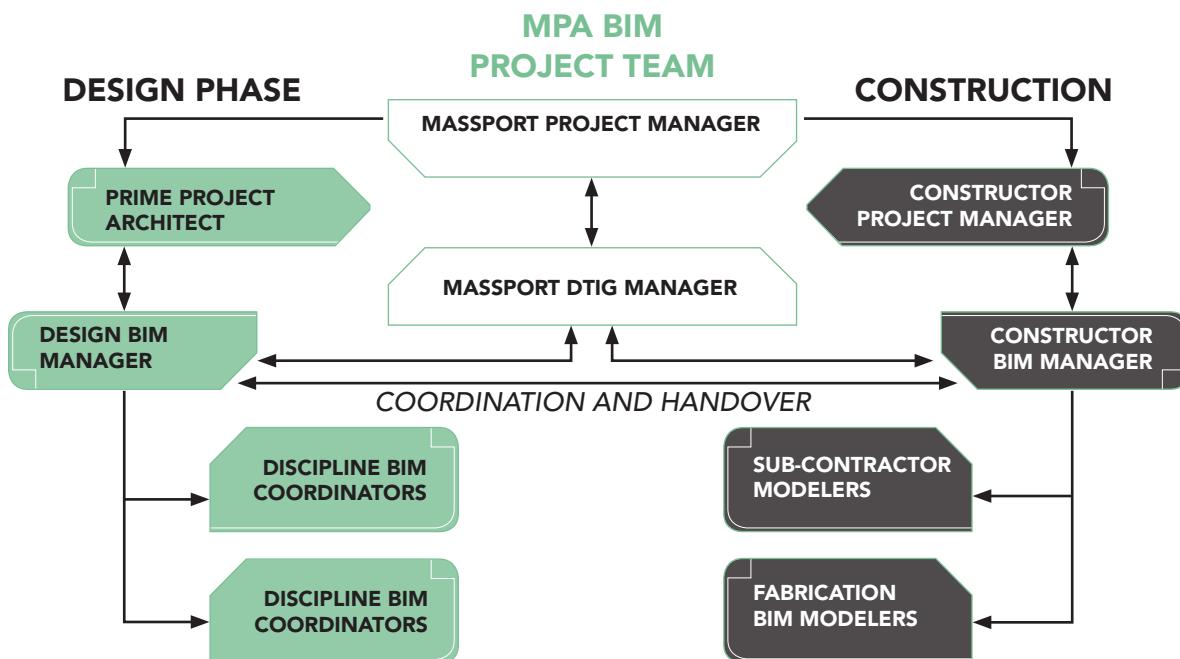


FIGURE 21 (MPA TEAM COORDINATION)

¹⁹ DTIG WILL COORDINATE WITH THE BIM MANAGER MODEL VERSIONING AND FILE NAMING, ANY PRE-APPROVED SPECIALTY SOFTWARE USED BY TEAMS FOR THE PURPOSE OF EXCHANGING INFORMATION, CONVEYING WORK PRODUCTS, AND SECURING TO MPA THE INFORMATION IT REQUIRES.

²⁰ THE BIM MANAGER WILL GET THIS INFORMATION FROM THE SURVEY MANAGER AS APPROPRIATE. THE RESPONSIBILITY FOR MAKING THE CONTROL POINTS KNOWN TO THE BIM TEAM(S) AND STANDARDIZING ON THE CONTROL POINTS RESTS WITH THE BIM MANAGER UNDER THE RESPONSIBILITY HEADING OF "COORDINATION."

²¹NATIONAL CAD STANDARDS

4.2.2 | Responsibilities Transferred from Design BIM Manager to the Construction BIM Manager

The BIM Managers shall facilitate model handover between design and construction and the ongoing coordination between the modeling teams. The Constructor BIM Manager will assume management of the following duties:

- Ensures development and compliance with the MPA BIMxP template;
- Ensures COBie²² or asset information is provided at milestone submittals, from the design team, contractor, and commissioning agent;
- Updates the BIMxP Model Progression schedule showing BIM Use execution and element LOD;
- Tracks the implementation of all agreed upon BIM Uses;
- Facilitates software and protocols training for the team's efficiency;
- Coordinates the setup of shared file server(s). This shall include setting up web portal, permissions, transfer protocols, versioning, model naming, sharing conventions, model partitioning, and other necessary and appropriate mechanisms for successful teamwork with the federated models;
- Assembles the federated model for coordination meetings;
- Defines the zones or packages for dividing large project models with teams to maintain model usability;
- Interfaces with MPA DTIG Manager for model review and handover;
- Coordinates BIM file exchange and archiving of milestone submittals;
- Coordinates with the constructor to ensure the creation of proper BIM final deliverables, including record model (as-built model);
- Coordinates update of as-constructed conditions in the Record/As-Built Model deliverable;
- Coordinates with Design Team and Commissioning Agent to ensure COBie information and MPA data requirements are accurate and complete.

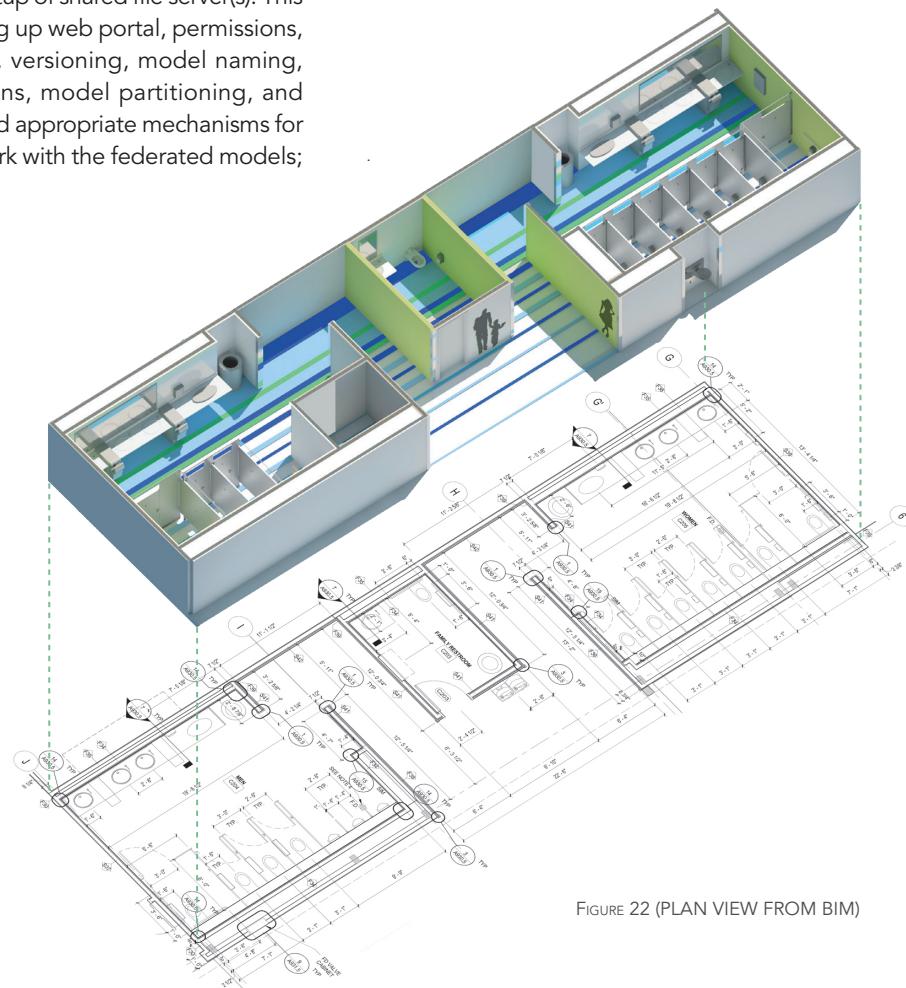


FIGURE 22 (PLAN VIEW FROM BIM)

²²CONSTRUCTION OPERATIONS BUILDING INFORMATION EXCHANGE (COBIE) [HTTP://WWW.WBDG.ORG/RESOURCES/COBIE.PHP](http://WWW.WBDG.ORG/RESOURCES/COBIE.PHP)

4.2.3 | The Constructor's BIM Manager Role

The design team's model will be shared with the constructor. "Constructor" includes the traditionally designated "General Contractor (GC)" or Construction Manager or CM at Risk (CM@Risk) as well as subcontractors in their capacities as both builders and influencers of design execution. BIM responsibilities of the Constructor BIM Manager include:

- Responsibility for BIM and the information developed during the construction phase;
- Developing the BIM Coordination Room (or "BIG Room")²³ specification for MPA approval;
- Ensuring that the Construction Team has the necessary hardware and BIM software properly installed and accessible for project use;
- Coordinating sub-contractor BIM development;
- Facilitating clash detection and resolution of hard and soft collisions reports using the MPA Clash Report template, and integrating subcontractor models and documentation;
- Coordinating construction sequencing and scheduling activities, and assuring they are integrated with the Construction BIM;
- Communicating with the Design Team, coordinating the data extraction sets required by the construction trades and ensuring that these requests are met;
- Coordinating with the Design Team to facilitate documentation of field design changes and timely update of the BIM(s);
- Working with Lead Fabrication Modelers to integrate 3D fabrication models with the updated design model prior to approval and installation, to ensure compliance with design intent;
- Working with the DTIG to coordinate model commissioning and data handover;
- Executing the responsibilities transferred from the Design BIM Manager, described in section 4.2.2.

4.2.4 | Discipline (Design) BIM Coordinators

All major discipline consultants shall assign an individual to the role of BIM Discipline Coordinator to manage model development, review and exchanges. These individuals shall have the relevant BIM experience required for the project and should have the following responsibilities:

- Coordinating discipline BIM development, standards, data requirements, as necessary, with the Prime BIM Manager;
- Leading the discipline BIM team in its documentation and analysis efforts;

- Coordinating clash detection and resolution activities;
- Coordinating internal and external BIM training as required;
- Coordinating specific discipline models into the Design Intent Model per the BIMxP;
- Coordinating information needed by MPA from trade and technical disciplines.

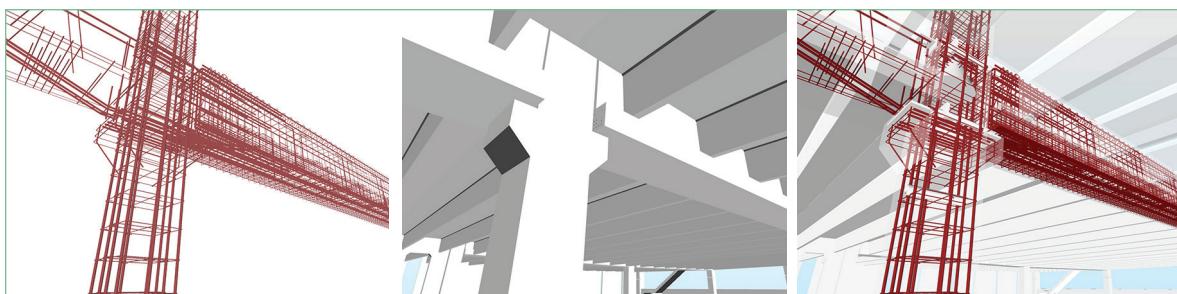


Image © Suffolk Construction Co // ConRAC

²³ "BIG Room" – A TERM USED FOR IN LEAN DESIGN FOR LARGE REVIEW ROOMS CAPABLE OF DISPLAYING BIMs FOR MODEL REVIEW AND KEEPING TEAM MEMBERS IN CLOSE PROXIMITY TO FACILITATE RAPID EXCHANGE OF MODELING STRATEGIES, TACTICS, AND DESIGN IDEAS.



Image © Parsons Brinckerhoff // ConRAC

4.2.5 | The Constructor BIM Coordination Role

In addition to the project scope of work requirements, the constructor shall provide consulting, leadership, oversight, and technical capability to support MPA's BIM objectives on projects. The CM shall provide expertise and resources to maximize the effectiveness of BIM and related technologies for program management, project and construction management, and other analytical services to improve quality, reduce costs, and gain operational efficiencies on MPA projects. Regarding BIM, the constructor shall:

- Facilitate development of the BIMxP, review BIM Use strategies defined by the team, and monitor execution;
- Provide oversight of the model progression, standards and data development, and BIM Use schedule execution developed in the BIMxP;
- Coordinate BIM reviews with MPA personnel for decision support;
- Work with Design Team and contractor to maximize BIM sharing and data re-use;
- Provide additional BIM capabilities to team if required to meet project scope.

4.2.6 | Trade BIM Coordinators

All major trades shall assign an individual to the role of BIM Coordinator to manage the sub-trade model development, sharing, and use. These individuals shall have the relevant BIM experience required for the project and assume the following responsibilities:

- Develop detailed models for Shop Drawing production;
- Support prefabrication, fabrication, and installation requirements;
- Manage model standards, data requirements, as necessary, with the Prime BIM Manager;
- Manage scheduled model updates and exchanges;
- Coordinate clash detection and resolution activities;
- Coordinate internal BIM training as required;
- Coordinate trade items into the Design BIM per the BIMxP;
- Coordinate information needed for COBie and MPA requirements from trade model

5

| Model Collaboration Environment

There are numerous meetings and communications to be documented and managed on projects. The Prime will provide a team collaboration site for general project communication. The project and BIM Manager will determine the schedule for project meetings when BIM will be used.

The Prime and its BIM Manager shall provide a team (physical or virtual) "Big Room", and model (digital) environment for reviews. If a CM is part of the project, then MPA may require the CM to provide a "Big Room" and server environment for the project. The procedures are to be documented in the BIMxP template

Collaboration Meetings – "Big Room"

A space for team meetings with virtual participation capability and BIM review capability. It includes equipment necessary for BIM review, and modification. Specifications for the BIM collaboration "Big Room" and equipment shall be provided to MPA for approval with the BIMxP. At or around the time the CM is retained, this responsibility will transfer the Contractor and its BIM Manager.

Virtual Collaboration

The project team will work with MPA to identify in-field BIM use requirements. Tools are documented in the BIMxP template.

BIM Server

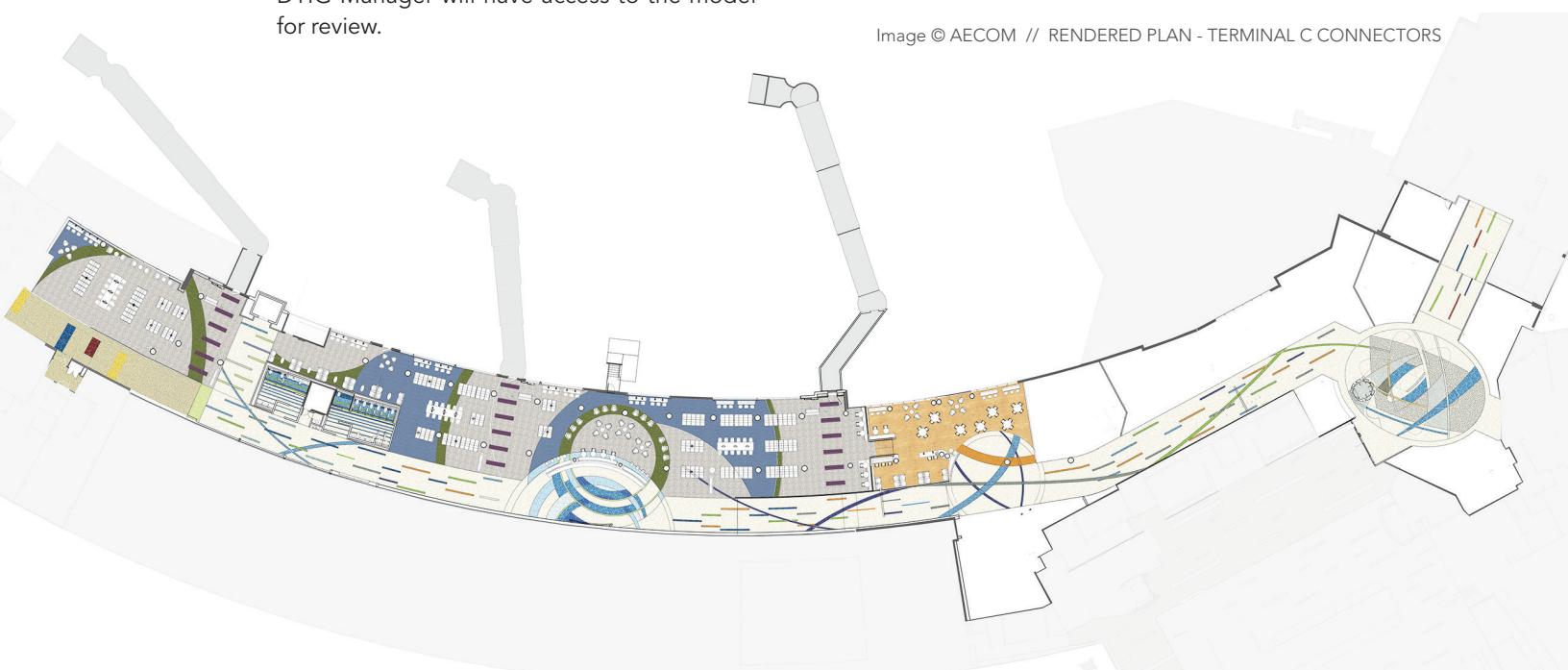
A BIM Server or shared model site is preferred to document management only sites. Procedures for model sharing, data development, document management, and secure model access, shall be documented in the BIMxP.

Training and Team Orientation

Appropriate training and instruction (manuals, pdf. training videos, etc.) materials shall be provided to team members requiring access and use of the model site. Training will assure team members can function effectively in a collaborative manner, with the necessary access to model data to perform their roles on the project. A schedule for this training shall be documented in the BIMxP.

A model viewer and training shall be provided for non-technical viewing of the model. Navisworks, or other viewers used will be documented in the BIMxP. The MPA project manager and the DTIG Manager will have access to the model for review.

Image © AECOM // RENDERED PLAN - TERMINAL C CONNECTORS



5.1 | BIM Development, Issue Resolution, Reviews and Approvals

BIM can be used in all phases of a project to problem solve, review design options, support decisions, and generate project documentation.

The Discipline specific work in progress (WIP) models are developed and federated to support BIM Use execution. The discipline teams are responsible for the model quality review and data validation of their model prior to sharing with the BIM Manager for federation.

The federated model is used for program validation, clash avoidance in design and detection in construction coordination, energy and other types of analysis, quantity take-offs, site and safety modeling, and many other uses of value on the project. The team should actively use model views, data and calculation reports, digital mock-ups, animations, plans, and other views to support more informed stakeholder decisions.

The design model should be regularly checked for conflicts and issue resolution documented in the BIMxP. Construction documentation should be derived from the resolved or "clash free" model. Native format models, Navisworks, Solibri Model Checking, and other viewers documented in the BIMxP may be used for model reviews, "Big Room" meetings, support of cluster meetings, and issue resolution and reporting throughout the project.

The contractor and subs shall work with the design model to develop shop models, pre-fabrication mock-ups and execute required BIM Uses per the BIMxP. The Contractor shall utilize model geometry and extract graphical information for generating construction administration documents from the Project BIM. Model reviews, RFI's, Directives, Bulletins, and Change Orders will be used per the agreed upon collaboration protocols in the BIMxP.

The design, shop models and drawings will be updated with as-built information in Navisworks as the As-Built model for project submission. An As-Built drawing set may be required per the BIMxP.

The design model (.rvt) will be updated with as-built information by the design team and submitted as the record model (.rvt) to MPA. This model shall maintain the discipline model linkage. MPA will review the model for compatibility with the MPA digital environment.

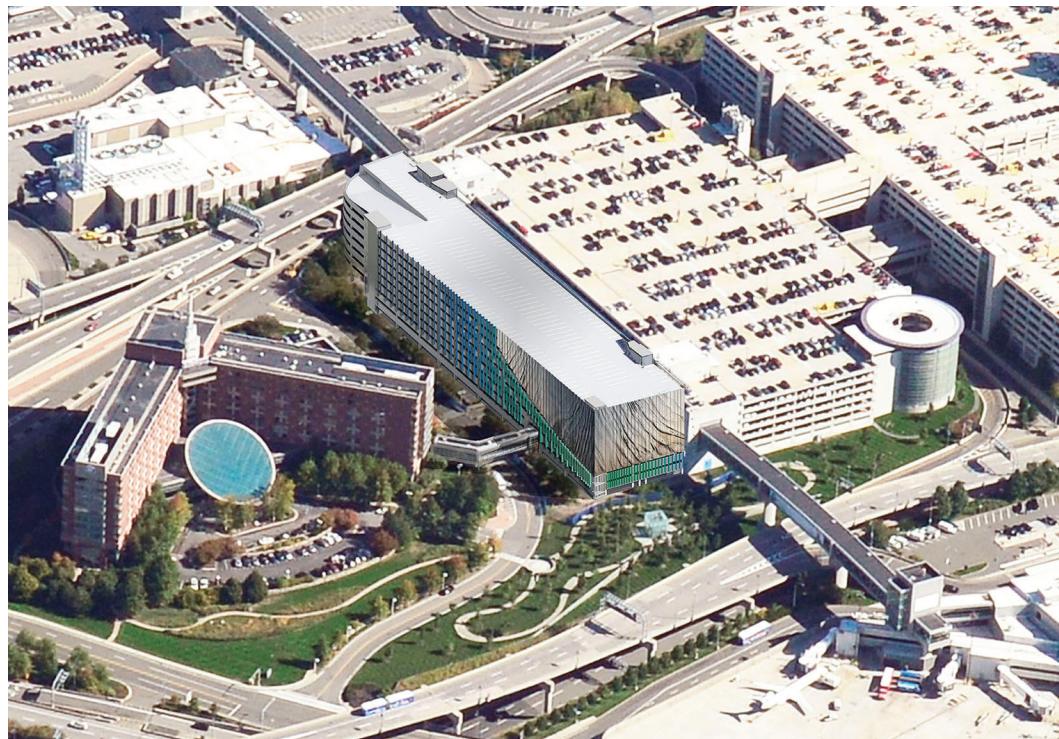


Image © Arrowstreet Architecture & Design // WEST GARAGE EXPANSION

6 | MPA BIM Framework

Standards, BIM settings, and industry best practices will be used to generate high quality information, efficient processes, and model sharing in a collaborative environment of discipline and focus teams. The Prime BIM Manager shall establish with the team the internal and external collaborative working guidelines, which maintain the integrity of electronic data and conform to MPA requirements.

Modeling techniques change regularly as software is improved. If new modeling methods conflict with this guide or are proposed as an alternative, it should be brought to the attention of the MPA BIM Manager for approval, and documented in the project BIMxP.



Photo © Robb Williamson / AECOM

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6.1 | BIM Authoring Software

MPA uses Autodesk Revit Suite for projects. Other applications require approval by the DTIG Manager and the application use documented in the BIMxP. Other applications might include:

- ▶ 3D CAD applications (AutoCAD, CADmep, CADduct, QuickPen, Civil 3D)
- ▶ BIM authoring applications (Revit Suite, ArchiCAD, Bentley BIM, Trimble Tekla Structures, SketchUp, Vico Office) MPA has standardized upon Revit
- ▶ BIM Programming applications (Affinity, Beck Technologies, Autodesk InfraWorks)
- ▶ Design coordination software (Navisworks, Solibri Model Checker, etc.)
- ▶ Cost modeling (Navisworks 2014, Modelogix, etc.)
- ▶ Scheduling Software (Synchro, Vico Office)
- ▶ Energy Modeling (Green Building Studio (GBStudio), IES, Ecotect, LBNL EnergyPlus, EcoDesigner Star)
- ▶ Project management software (Prolog/Proliance, e-Builder, CMiC, Vico Back Office, Newforma, etc.)
- ▶ Data management software (EcoDomus PM, Solibri)

BIM authoring tools and non-BIM applications used on the project will be documented in the BIMxP. MPA DTIG Manager will approve application use on the project. The Design or Constructor BIM Manager will test applications that are proposed for use on the project before the application is submitted to MPA for approval. This testing and structure will be documented in the BIMxP.

6.2 | Model Structure

Models shall contain accurate 3D views, plans, sections and elevation views for assembly and final publication. The model should include saved views for model review and future use by MPA.

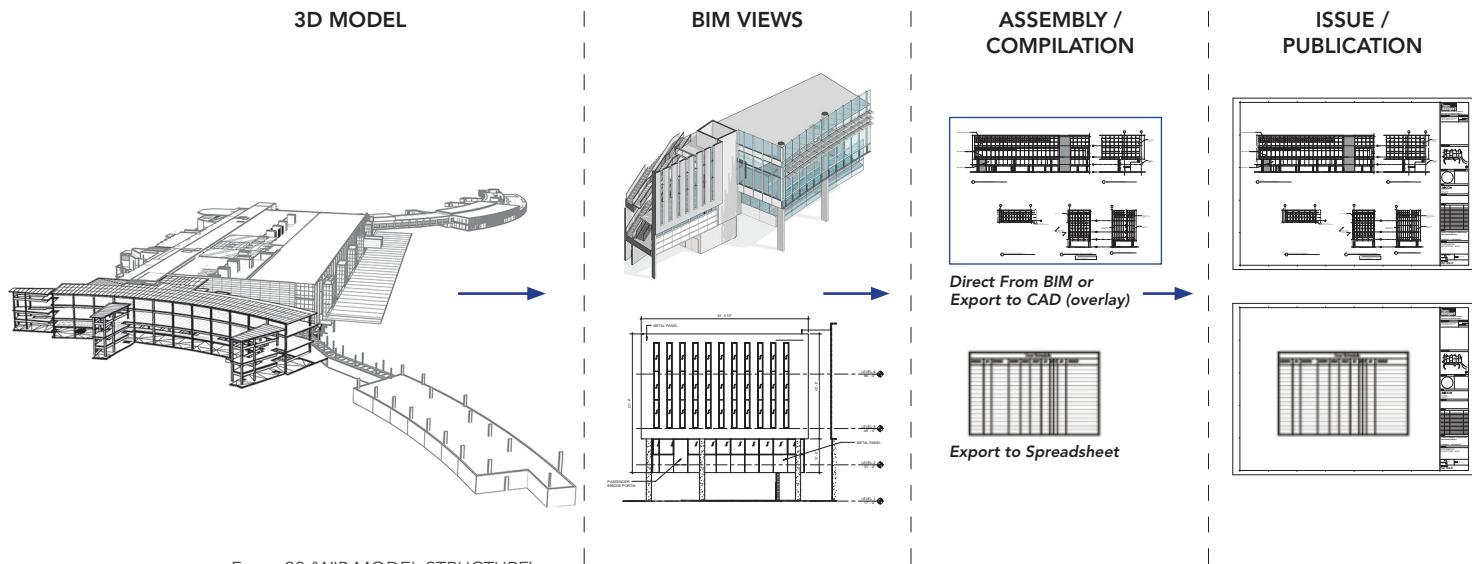


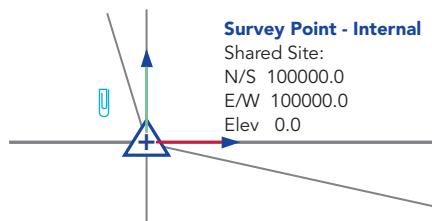
FIGURE 23 (WIP MODEL STRUCTURE)

6.2.1 | Model Geo-Reference

MPA requires models be correctly placed in 3D space using the real-world coordinate system for the building grid supplied by the DTIG Manager. The prime BIM Manager shall establish the project shared coordinate system across all BIM data files to allow them to be referenced without modification. Once established, spatial coordinates shall only be changed by mutual consent of the team and the MPA project manager, and recorded in the BIMxP, and promptly published to all team members. Once the design coordinate system is agreed upon, any model(s) of existing buildings relevant to the project shall be converted into the coordinate system used for each designed building.

Revit workflow dictates that building models are created orthogonal to the screen and at zero elevation. The location of the building at real-world coordinates, true heights, and shared coordinate systems are established by the BIM Manager in the site model. The model shall use true height above project datum.

The building within a BIM file shall include a geo-reference for site location at larger scale views. Not all projects will require a site view. Geo-referenced site plans and building models for site layout surveying, and future GIS use shall be in accordance with the State Plane Coordinate system where the project is located.



6.2.2 | Points of Reference – 3D Building Grid

Depending upon the size of the project, the prime BIM Manager shall provide a 3D grid for incorporation into the spatial coordination model. This will provide the viewer with a quick point of reference when navigating through the model. This grid will be part of the As-Built deliverable to MPA.

6.2.3 | North Arrows

Both true north and project north shall be on construction sheets as required for documentation.

6.2.4 | Modeling Tolerances

Model elements are to be modeled within one-eighth inch (1/8") of actual location (3mm). The automated dimension strings in the BIM software should be used. Dimensions in derived 2D drawings should sum correctly within tolerances specified in the BIMxP. Dimension strings shall retain their associativity. If laser layouts (total station) are used in the field or prefabrication is required, then the modeling teams will review the tolerances required in those areas and for that building system component with the CM or trades. Results of such a review and any adjustments affecting current and future modeling shall be documented in the BIMxP.

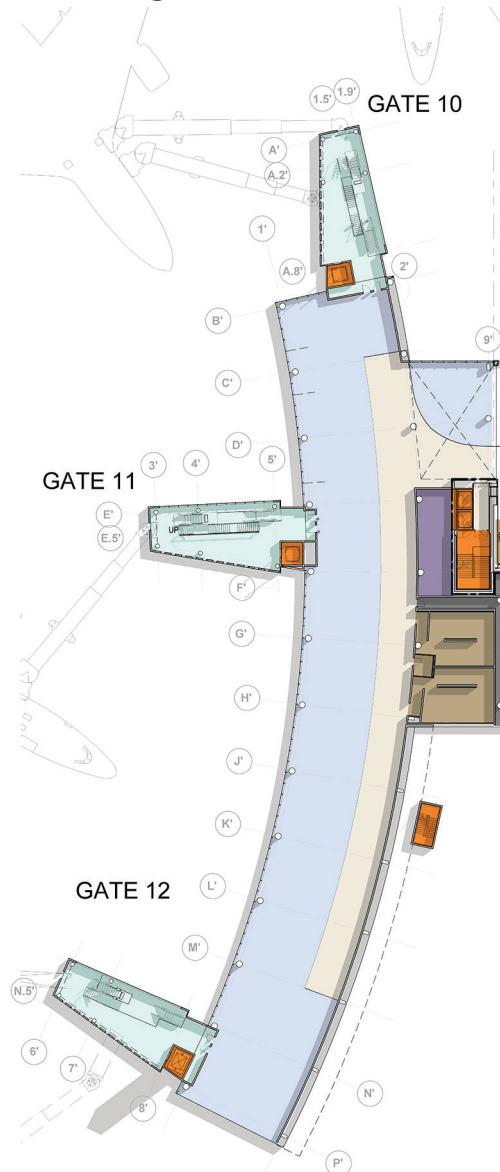


Image © AECOM // BIM COLORED PLAN - TERMINAL E

6.3 | BIM Objects, Assemblies, Elements, and Components

Use BIM authoring software element libraries when creating model objects. Models shall be composed of the software's model elements for representing building products, rather than geometric lines, arcs, and vertices.

All objects and components will be modeled or created using the tool in the software prescribed, or created for the purpose. If a new object is created then it must be designated as the real world element it represents, having the proper class or family data attributes for the project and that object type.



FIGURE 24 (GENERIC TO MANUFACTURER SPECIFIC OBJECTS)

Objects, assemblies, components shall report properly from the BIM software as the architectural elements they represent rather than unassigned graphic primitives. When represented as architectural elements, the information associated with these elements will be properly updated, reported, and available for export to downstream "consumers" as the design evolves.

Generic Objects

BIM applications include generic representations of building products, assembled elements, and components of building systems.

Manufacturer's Model Product Objects and Elements

Objects and elements acquired from manufacturers often have more information or geometric detail than is necessary to keep in the BIM. The BIM Manager shall determine if the manufacturer object is appropriate for the model. The object should retain its overall dimensions and critical components. Embedded performance data shall be retained for analysis and specification purposes.

Custom Created Model Elements

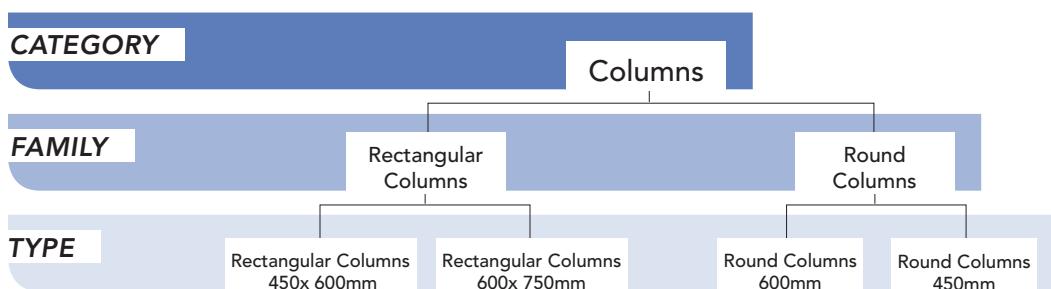
Teams may create BIM objects and elements utilizing the appropriate BIM authoring tool templates and procedures. These must be assigned to the correct category, family, type, and/or sub-type according to the authoring software's best practices, and they must carry the required and desired attribute data consistent with BIMxP standards. Object creation management, classification, and attribute inclusion and mapping (sometimes called "library management," "family management," "sub-type management") must be done in standardized ways consistent with BIMxP requirements, following best practices for the BIM authoring tool. Objects created by scripting, or that incorporate custom scripting in the BIM authoring tool's environment, shall be thoroughly documented and included as part of the work product being delivered to MPA. Live, editable instances of BIM objects so created must accompany the BIM deliverable so that all Use Cases identified in the BIMxP continue to be supported by the model after model handover to MPA. Support for correct IFC output shall be maintained by custom objects. Objects generated in the development of a project will be stored in the WIP area of the project folder structure.

6.3.1 | Object Element – Time Sensitive Data

Objects that have time-sensitive data in their attribute fields, should also carry a date, time, source, and cause of data refresh or update, whether that cause be a data import operation or a person modifying the object. The metadata included in this way must be reportable, so downstream consumers can know how fresh the data is and can identify the authoritative source.

6.3.2 | Master Attributes

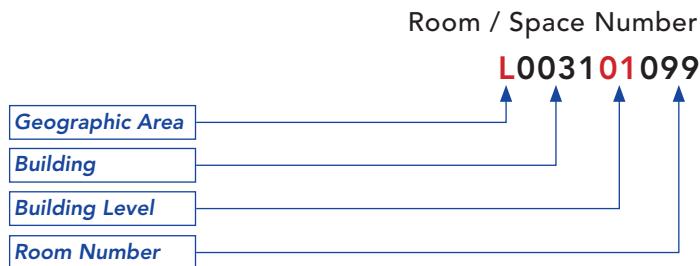
Within the Revit model, attributes are assigned and data developed for specific objects and elements. If COBie BIM Use is specified, then COBie requirements take precedent.



6.3.3 | Space Naming, Room Numbering, and Coding

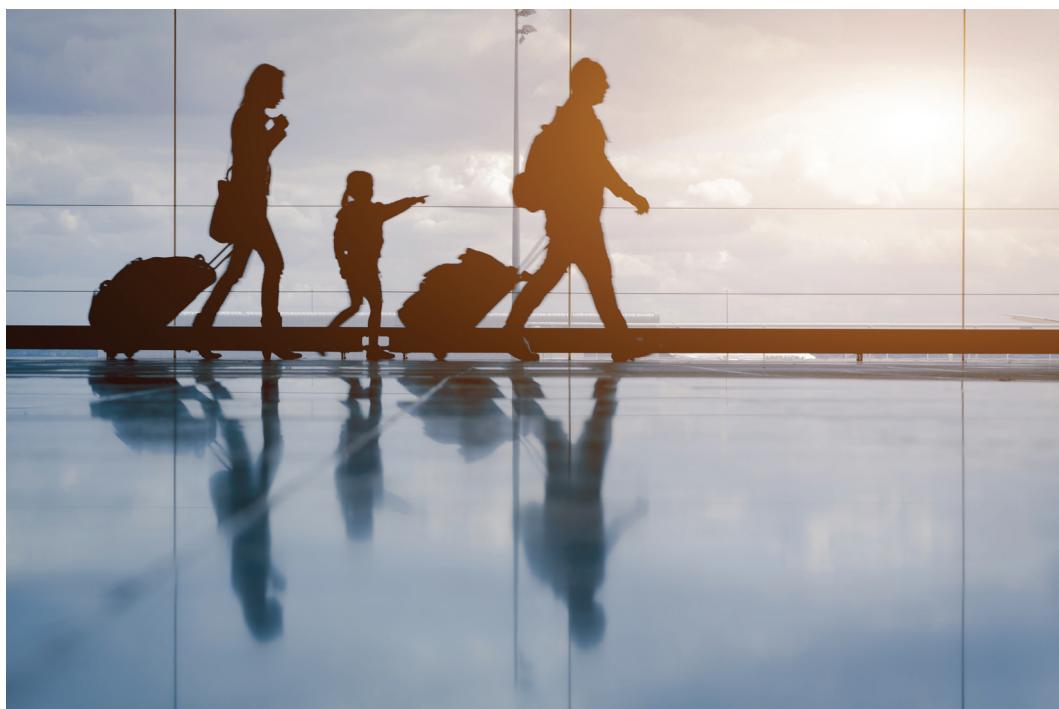
Areas of four square feet or greater shall be tracked and identified by name. Each model shall include the following attributes to be maintained throughout the Design and Construction BIM models:

- ▶ **Building** - Name, Number Code & Location
- ▶ **Floor / Level**
- ▶ **Department**
- ▶ **Sub-department**
- ▶ **Space Name** - English Name & Abbreviation
- ▶ **Room Number** - MPA Wayfinding Room Number
- ▶ **Room Number** - Construction Document Number (used on large complex projects for builder use)
- ▶ **Space Type** - OmniClass Table 13 assigns the function space type as opposed to the room number
- ▶ **Unique Space Number** - GUID
- ▶ **Space Measurement** - Net Square Footage (NSF),
Department Net Square Footage (DNSF),
Department Gross Square Footage (DGSF),
Building Gross Square Footage (BGSF)



Elevator, Escalator, Stairs, Bathrooms, Roof, Basement, and Gates

FIGURE 25 (MASSPORT ROOM NUMBERING)



Whenever calculating the Building Gross Area, Departmental Gross Area, or Net Assignable Area, the Designer shall adhere to the following specific methods of area calculation:

Building Gross Area

The floor area of a building for all levels that are totally enclosed within the building envelope, including basements, mezzanines, or penthouses. To compute Building Gross Area, measure to the outside face of exterior walls, disregarding cornices, pilasters, and buttresses, that extend beyond the wall face. The Building Gross Area of basement space includes the area measured to the outside face of basement foundation walls.

Departmental Gross Area

The net assignable areas and required secondary circulation assigned to an occupant group or department. To compute the Departmental Gross Area, measure to the inside finished surface of the exterior building walls, to the finished surface of the walls surrounding major vertical penetrations and building core and service areas, and to the center of the walls dividing the space from adjoining Departmental Gross Areas.

Net Assignable Area

The area required to accommodate a function, equipment, occupant, or occupant group. Net Assignable Area includes interior walls, building columns, and projections. Net Assignable Area excludes exterior walls, major vertical penetrations, building core and service areas, primary circulation, and secondary circulation. To compute the Net Assignable Area, measure to the inside surface of the exterior building walls, to the finished surface of walls surrounding major vertical penetrations, building core areas, and service areas, and to the center of partitions separating the Net Assignable Area from adjoining Net Assignable Areas and from secondary circulation space.

6.3.4 | Revit Wall Type Naming Conventions

Wall types are in place elements in Revit. They are defined, utilized and stored in a Revit project file or Revit template.

Wall type naming conventions allow for easy identification in the type selector menu. These names cannot be driven from the wall type parameters. This means that some information about the wall type will be duplicated.

The recommended wall type naming consists of identifying the primary function followed by the core thickness, structure and finish. Add additional parameter information for Fire rating as needed. The type selector will automatically sort alphabetically. This naming convention keeps similar types together and easy to locate.

The MPA DTIG Manager will review a team's wall naming conventions for use on MPA projects.

< Function > < Mark > < Core Width > < Structure > < Finish > < Modifier >

Exterior 10A - 8" CMU - GWB 2 Layers

6.4 | View Naming and Model Navigation

A view-naming standard shall be documented in the BIMxP for ease of model navigation. This standard is limited to drafting views and sheet views, although the Project Browser includes other kinds of elements that may also be documented.

- Level names are spelled out as they need to appear in a room schedule, as well as how they will appear in sections and elevations. Do not pad the level number with leading zeros.

- ▶ Views shall not be named in order to make them sort or group more logically in the Project Browser as the grouping and filtering settings take care of that automatically (i.e., the prefixing of level names by sequential numbers). Data management software (EcoDomus PM, Solibri)
- ▶ View names shall be written in UPPERCASE.
- ▶ Creation of temporary working views is encouraged.

6.4.1 | Special Views

Plan views differ in Revit from other views because they can be duplicated (without reproducing their reference mark as is necessary with elevations and sections). This result in many special-purpose plans that are temporary and may never be placed on title sheets.

These views and other extraneous model information shall be purged from the model before submission for review.



MPA and industry data standards are necessary to achieve a consistent BIM deliverable across multiple projects. These standards include model metadata, model structure, object and element attributes, naming conventions, and LOD.

The MPA DTIG must approve deviation from these standards in writing before proceeding with any work that contradicts or implies modification of these standards.

7.1 | Data Standards for MPA BIM

MPA currently uses UniFormat and MasterFormat in its projects. As part of the move to BIM, MPA is transitioning to the Construction Specification Institute (CSI) OmniClass™ Construction Classification System (OCCS).²⁴ The OmniClass Tables are part of the National BIM Standard (NBIMS).

- ▶ **Table 11 - Construction Entities by Function**

- ▶ **Table 13 - Spaces by Function**

UniFormat does not classify spaces.²⁵ Space tracking is essential for MPA to review program compliance and manage its building portfolio. In BIM, space tracking using Table 13 number and name classifiers are to be used in the model space attribute

- ▶ **UniFormat - 2010**

- ▶ **MasterFormat**

- ▶ **Table 31 - Phases**

The BIM Execution Plan (BIMxP) Template, Section 5 uses Table 31- Phases. The phases are listed below with a cross-reference to traditional design and construction project phasing.

Table 31	OmniClass Phase Name	Traditional Phasing
31-10 00 00	Inception Phase	Project Planning
31-20 00 00	Conceptualization Phase	Schematic Design
31-30 00 00	Criteria Definition Phase	Design Development
31-40 00 00	Design Phase	Design Development
31-50 00 00	Coordination Phase	Construction Documentation
31-60 00 00	Implementation Phase	Construction
31-70 00 00	Handover Phase	Commissioning, Project Close-out
31-80 00 00	Operations Phase	Facilities Management, Operations
31-90 00 00	Closure Phase	Closure, Decommissioning

- ▶ **Table 41 - Materials**

- ▶ **Table 49 - Properties**

7.1.1 | UniFormat Transition

MPA will identify whether UniFormat, OmniClass, or a specific MPA standard will be used for cost estimating, building assessment projects, or other work products. The use of all standards will be identified in the BIMxP for the project.

7.2 | Model Data Requirements

The model carries data within a hierarchy of model development. Each discipline, federated, and design model carries its MPA project metadata.

- ▶ **Project ID - MPA Construction Project Number**
- ▶ **Building ID – Provided by MPA**
- ▶ **Building Type - OmniClass Table 11**
- ▶ **Project Name - Provided by MPA**

²⁴ ALL OMNICLASS TABLES, AND EDUCATION OPTIONS ARE AVAILABLE AT: WWW.OMNICLASS.ORG

²⁵ SEE [HTTP://WWW.CSINET.ORG/FPIUF](http://WWW.CSINET.ORG/FPIUF) FOR A DISCUSSION OF THE DIFFERENCES BETWEEN UNIFORMAT AND MASTERFORMAT, AND THE INTRODUCTORY TABS FOR EACH OCCS TABLE, WHICH CONTAIN REFERENCES TO OLDER UNIFORMAT AND MASTERFORMAT CLASSIFICATION SYSTEMS

8

| Drawing Requirements for Paper Printing & Publishing

This section provides graphic standards for BIM based construction-drawing documentation. The model metadata, object, element, and component attributes in the model shall conform to MPA standards included in model-derived schedules and reporting. The MPA Project Manager and the DTIG Manager must approve deviations from these requirements in writing before proceeding with the work.

The Prime's BIM Manager shall attend a mandatory project initiation meeting with a member of the DTIG to review the BIM standards, CoS selection and BIMxP development, and submission requirements.

8.1 | Drawing Requirements for Paper Printing & Publishing

Construction drawings (CDs) are required submissions on projects. In a BIM-based project, these drawings (plans, sections, elevations, 3D details, axonometric views) shall be derived from the model. Object, component, and element attribute data shall be fully parametric so that equipment, fixtures, and building elements information can be generated from the model for quantity take-offs, finish, door and other necessary construction schedules. Drawings may be published during project development in native format, .rvt, web views .dwf, .nwd, .pdf, and .dwg.

PRECEDENCE OF BIM DESIGN MATERIALS

Massport's objective is for the Design Model to function as the primary means of communicating the Project's design intent. However, Massport recognizes that in limited situations, two-dimensional drawings (that may or may not be derived directly from the Design Model), as well as other subsidiary three-dimensional models (or model elements) may co-exist or supplement the Design Model as the primary means of communicating design intent. Thus, there may be situations where the Design Model is in conflict with these materials. This is especially true in situations involving dimensional accuracy. In order to address this contingency, Massport has developed the following order of precedence for conflicts by and between these BIM design materials. The below is intended as a substitute for the term "Plans and or Drawings ("Plans")" in Article 31 of Massport's Standard Construction Contract entitled: Coordination of Plans and Specifications:

In situations where there is a conflict by or between the project's BIM design materials, the following order of priority/precedence shall apply:



- ▶ Drawings that are derived from the Design Model but are supplemented with independent or additional graphics and annotations; followed by
- ▶ Drawings that are derived directly from the Design Model; followed by
- ▶ Model Element(s) that are specifically identified as superseding a component of the Design Model; followed by
- ▶ The Design Model; followed by
- ▶ Drawings that are developed independently from the Design Model.

8.1.1 | Drawing Requirements for Paper Printing & Publishing

Every sheet, including the title sheet, must include the applicable stamp of a Registered Professional Engineer and/or Architect licensed in the Commonwealth of Massachusetts, with the Engineer or Architect of Record's (Prime Consultant and all Sub-Consultants) signature over the seal. Both the seal and signature must be readable when reproduced.

8.1.2 | File Naming Format

The naming of project documentation files (for examples, .TIF, .PNG, .PDF, and .DOCX, .MOV, etc.) shall include the following information and sequence.

L404C01 – A100.PDF
 MPA Project Number Dash Drawing Number

FIGURE 31 (FILE NAME EXAMPLE)

8.1.3 | Drawing Layouts & Title blocks

The MPA Title Block and Information shall be adapted for BIM use by the Design Team. It will be provided by DTIG team by request.

SIZE / MARGINS:

The outside dimensions of both preliminary and final working drawings must be either 24 x 36 inches, 30 x 42 inches, or 36 x 48 inches. The Project Manager will designate the appropriate drawing size. Within these dimensions, drawings must have a ½ -inch border on the top, bottom, and right sides, and a 1-inch border on the left side.

TITLE SHEET:

A title sheet must accompany each set of drawings, unless The Authority waives this requirement. The title sheet should contain a proper and accurate indexed list of applicable drawings.

SHEET IDENTIFICATION, SEQUENCE, AND INDEX:

All drawing sets must include a complete index on the cover sheet that lists individual sheet titles and numbers for all disciplines in the set. This naming convention shall follow the National CAD Standards (NCS)

- ▶ Legends, graphic symbols, and general notes must appear on the first sheet of each discipline's set of drawings.
- ▶ Discipline sheet sequencing shall follow the NCS standard.

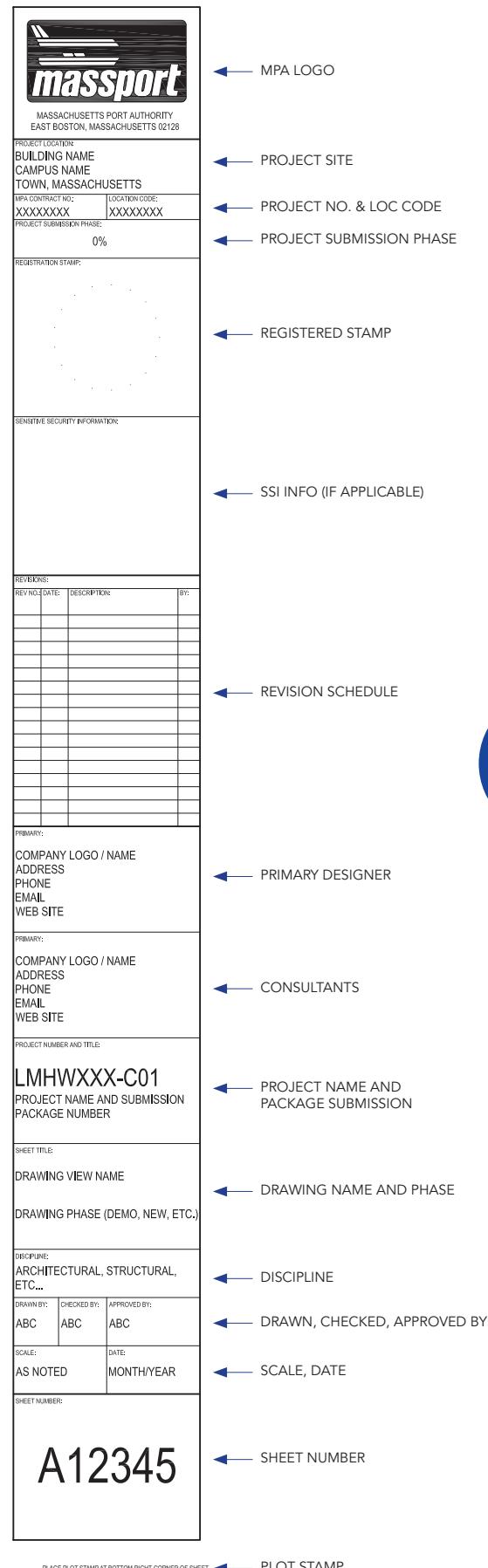


FIGURE 26 (MASSPORT TITLE BLOCK)

KEY PLAN:

A key plan must be shown in the lower right-hand corner of all sheets having floor plans, elevations and building sections. The plan must identify the area depicted on the sheet. The key plan orientation must be the same as the floor plan orientation on the same sheet.

PLAN VIEWS:

All drawings in a set must be oriented in the same direction.

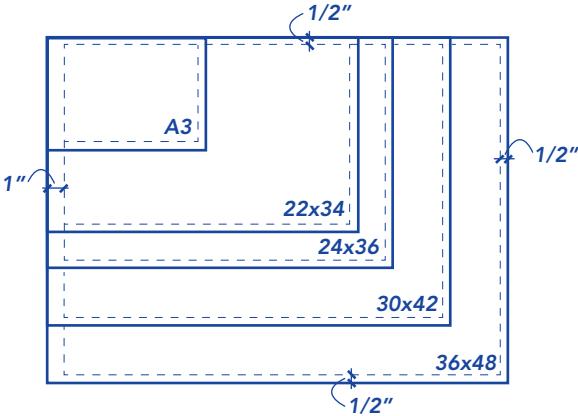
SCALES ON DRAWING SHEETS:

The scale of the drawings must be shown on each plan, elevation, section and detail. Each drawing must include graphic scales. The following designated scales are required as a minimum:

LAYER CONVENTIONS :

MPA utilizes the NCS v5 layer standards with the following exception:

Layers used by the design team should be submitted as part of the BIMxP.



- ▶ Floor Plans $1/8''=1'0''$
- ▶ Mechanical/Toilet Rooms $1/4''=1'0''$
- ▶ Elevations $1/8''=1'0''$
- ▶ Building Sections $1/8''=1'0''$
- ▶ Refl. Ceiling Plans $1/8''=1'0''$
- ▶ Wall Sections $3/8'', 1/2''$ or $3/4''=1'0''$
- ▶ Roof Plans $1/16''$ or $1/8''=1'0''$ Site/Civil Plans $1'' = 20'$ or $40'$
- ▶ Graphic scales must be included on all drawings.

8.1.4 | Horizontal Construction

The Authority currently has separate AutoCAD layering standards for site/civil drawings. These layers are listed within the drawing named "MPA-SITE-CIVIL-LAYERS.dwg". Layers created that have additions, deletions or enhancements should be named with the appropriate prefix added to the Authority's existing site/civil layering standards. Separate text layers must also be created for any new text added to the drawing.

The following is a list of prefixes:

Y - survey information

ASB - As Built information

DES - design or proposed information

DEMO - demolished information

ABD - abandoned information

Existing information uses the Authority's Site/Civil/Utility layering standards without a prefix

Project Limits

Each Project will require a layer called "CAD-PROJECT-LIMITS-L", which will be drawn around all project work areas.

Site/Civil Drawing Coordinate System

AutoCAD site/civil basemaps supplied by the Authority are created in relation to its geographic location. The insertion base point (0, 0) can be related to a control network of other nearby sites. The horizontal control network of the basemap uses the Massachusetts Mainland State Plane Coordinate System (Zone 2001), as referenced to the North American Datum of 1983 (NAD83). The vertical component of the network is referenced to the National Geodetic Vertical Datum of 1988 (NAVD88). Site/Civil Basemaps should **NEVER** be moved or rotated in a manner that removes the drawing from the control network. If the orientation of the basemap needs to be changed, the use of Paper Space with a User Coordinate System should be used to rotate the perspective of the basemaps. Decimal units are used for all Authority site/civil/utility basemaps.

Utility Line Data

Utility lines SHOULD NOT be broken for the purpose of annotation. Utility lines should run continuously from structure to structure. Lines should be annotated above or below the line.

North Arrow

An arrow indicating north must be shown at the upper left-hand side of the drawing of all floor plans, including site/civil, architectural, structural, plumbing, fire protection, mechanical and electrical drawings.

Clearances

Mechanical Room drawings must graphically show access door swings on A/C equipment and coil filter removal clearances. A model view shall be provided to further identify access and maintenance clearance. Consideration must be given not only to the space required to perform maintenance, but to the space required to gain access to the maintenance space with maintenance equipment and tools.

Building Area & Volume

Drawings must show accurate building areas and volumes to foster accurate comparisons of the project areas and volumes compatible with construction industry standards. MPA will review the criteria to be used. BIM volumes, color coded with areas/volumes reported must be provided for all projects, and the building areas must be recorded as a schedule on the Architectural Drawings.

8.1.5 | Standard Details and Finishes

A different partition type is to be created for each type of wall used in the project with each type to be constructed in 3-dimensional form.

8.1.6 | Font and Lettering Size

Lettering: A minimum letter size of 1/8 inch for notes and 1/4 inch for titles must be used to allow them to be reproduced in one-half of their size. All lettering must be in vertical capitals. Text font is Arial Narrow for notes and Arial Narrow for titles

8.1.7 | Text in Files

It is recommended that the following text assignments be used in MPA projects.

TEXT HEIGHT (mm) PLOTTED FULL SIZE	LINE WEIGHT ALLOCATION	USAGE
1.8	2	General text, dimensions, notes - used on A3 & A4 size drawings
2.5	3	General text, dimensions, notes
3.5	4	Sub-headings
3.5	5	General text, dimensions, notes - A0 drawings
5.0	7	Normal titles, drawings numbers
7.0	8	Major titles

8.1.8 | Line Styles and Line Weights

The internal software BIM Line Style defaults shall be used instead of the NCS and MP Linetype definitions. The A/E has the discretion and responsibility to edit the default line weight values of the BIM software so printed documents reflect the graphic intent of NCS and MP standards.

8.1.9 | MEP Details (2D)

2D details from BIM MEP software do not always produce traditional component construction representations. Tagged definitions of the MEP object /elements shall be provided for clarity.

8.1.10 | Project Documentation Schedules

Schedules will be derived from the model with additional information supplied by the project team member responsible for schedule data. Information will be organized in every schedule in a similar format with a heading, mark column, distinguishing characteristics²⁶, and the notes column. Numbers and note legends are recommended for schedules with duplication of note information in the note column, and to minimize the size of the schedule.

Notes Legend:				
	HEADING			
	MARK	ITEM DESCRIPTION	DISTINGUISHING FEATURE	NOTES
1 Note A				1,2
2 Note B				3
3 Note C				5
4 Note D				2,3
5 Note E				4

FIGURE 27 (NATIONAL CAD STANDARD - UDS SCHEDULE)

8.2 | Discipline Model Drawings

Traditional discipline drawings are to be derived from the model whenever possible. Details should be based upon model information to remove contradictory information.

8.2.1 | Architectural Drawings

These drawings should be identified as "A" drawings, dimensioned, and should include at least the following items:

- ▶ Plans of all spaces and views including floor, reflected ceiling, power/data/communications and roof plans
- ▶ All fixed and specialty equipment
- ▶ All permanent fixtures
- ▶ Overall building elevations and building sections through the structure(s)
- ▶ Overall building elevations and building sections through the structure(s)
- ▶ Additional building sections as are needed to clearly illustrate the interior elevations
- ▶ Exterior and interior wall sections for all typical and all unique conditions showing construction and materials

²⁶ NCS, v5 - DISTINGUISHING FEATURES ARE DISTINCT, DIFFERENT, OR DEFINING CHARACTERISTICS THAT SPECIFICALLY DESCRIBE SPECIAL INFORMATION RELATED TO THE ITEMS CONTAINED IN THE SCHEDULE. DEPENDING ON THE SCHEDULE'S COMPLEXITY, EACH SCHEDULE MAY CONTAIN MULTIPLE COLUMNS FOR FEATURES.

- ▶ Enlarged sections through stairways
- ▶ Enlarged plans and elevations of toilet rooms showing finishes, fixtures, casework and accessories
- ▶ Roof details including roof drainage outlets, flashing details, insulation, pitches of roof, chimneys, vent housing and the like; including all penetrations for vents, conduits, mechanical equipment, flues, pitch pockets and curb/wall details
- ▶ Partition schedule defining and detailing each interior partition type
- ▶ Room finish schedule documenting all finishes for each occupied and unoccupied interior space
- ▶ Door and window schedules defining and detailing all exterior and interior windows, doors and louvers
- ▶ Detail drawings showing construction and materials
- ▶ Enlarged sections through the structure(s)
- ▶ Detail sections of windows, doors, permanent fixtures, finishes and similar basic elements of the structure(s), curtain walls, exterior walls and building system interfaces
- ▶ Casework details
- ▶ Signage schedule, plan and details
- ▶ Location of all mechanical and major electrical penetrations through walls and floors
- ▶ Mechanical conveyance equipment (e.g., elevators, escalators, conveyors, cranes, etc.)
- ▶ Plans and details of construction barriers
- ▶ Color and material boards on architectural projects

8.2.2 | Structural Drawings

These drawings should be identified as "S" drawings and show at least the following items:

- ▶ The foundation construction, materials and details with the locations and sizes of all piles, caissons, spread footings, floating slabs, pressure injected footings as applicable;
- ▶ Design soil bearing pressures shall be indicated on the foundation plans;
- ▶ Complete foundation wall elevations showing location, dimensions, and grades for all floorings, steps and wall openings;
- ▶ Elevations of top of structural slabs and finish floor elevations; complete dimensions for all openings, depressions, and changes in elevation of structural slabs; concrete floors relative to granolithic finish and concrete topping;
- ▶ Complete dimensions and schedule for all lintels, beams, joists and columns;
- ▶ Typical structural sections showing methods of connection, floor and roof deck selection, and the methods and locations of lateral bracing;
- ▶ Complete dimensions and details for all members of the superstructure and for all expansion and construction joints;
- ▶ Design live load for each roof and floor area;
- ▶ Class and 28-day strength of concrete for each portion of the structure;
- ▶ Boring plan, log of borings, date(s) borings were taken (bottom grades of footings, ground elevations, and slab and water elevations shall be plotted on boring schedule);
- ▶ Framing plans and schedules showing location, size and description of all columns, beams, joists and all other framing members; and
- ▶ Location of all major mechanical, plumbing, and electrical penetrations through walls and floors.

The Structural Drawings shall show all of the project's design loads, and indicate allowable live loads for all of the various floor and roof areas requiring different allowable live loads and snow load conditions including:

- ▶ Drift conditions;
- ▶ Horizontal loads for wind and hurricane design conditions, if applicable;
- ▶ Seismic loadings for earthquake conditions, where applicable;
- ▶ Concentrated loads and penetration resistance for special equipment;
- ▶ Deflection loading;
- ▶ All other applicable design loads.

8.2.3 | Plumbing Drawings

These drawings should be identified as "P" and show the following necessary items:

- ▶ A complete operative system of storm water and sanitary piping connecting to all drains, fixtures and equipment and extending to ten (10) feet from the outside of the building;
- ▶ A complete system of cold and hot water distribution and re-circulation piping connecting to fixtures and equipment;
- ▶ Insulating covering on all cold, hot and rain water piping and on other piping types as necessary;
- ▶ Hot water storage heater, including insulation, controls, relief valves, thermometer, piping connections and appurtenances;
- ▶ Boilers and associated venting;
- ▶ Backflow preventors in accordance with BWSC and State Plumbing Code;
- ▶ Wall hydrants;
- ▶ All interior sleeves, wall and floor plates, brackets, hangers, inserts, expansion sleeves, fixture supports and appurtenances;
- ▶ Trap primers, floor drains, and special purpose drains to receive sanitary wastes;
- ▶ Shower receptors and service sink receptors;
- ▶ All plumbing fixtures;
- ▶ Hot water circulating pumps and controls;
- ▶ Grease interceptors and flow controls for kitchen sinks;
- ▶ Traps and vents for all equipment;
- ▶ Control valves;
- ▶ Toilet room and shower room accessories;
- ▶ Equipment and valve name tags and/or plates;
- ▶ Water supply and drainage to air conditioning units and incinerating scrubber;
- ▶ Shut-off valves on each water service to a group of fixtures;
- ▶ Access panels for valves and cleanouts;
- ▶ Concealed air chambers on each water supply to each fixture;
- ▶ Water service connection;
- ▶ Complete operating systems for distribution of all air, gas, or vacuum requirements;
- ▶ Natural gas and/or propane piping;
- ▶ System riser diagrams;
- ▶ Gas and other ancillary systems;
- ▶ Piping, filters, controls and accessories; and
- ▶ Temporary services.

All piping shall be accurately sized and indicated on drawings and riser diagrams. Show directions of flow and pitch on piping. Utilize 3D views to show maintenance areas and pitch.

8.2.4 | Fire Protection Drawings

These drawing should be identified as "FP" and show the following items:

- ▶ Design layout and details.
- ▶ Fire Protection Drawings shall provide the level of detail indicated in MPA Standard Specification
- ▶ The Consultant should also refer to Exhibit 3, Narrative Reports, Fire Protection.
- ▶ Fire Protection riser diagram.

8.2.5 | Mechanical Drawings

These drawings should be identified as "HVAC" drawings and show Heating, Ventilation and Air Conditioning Systems including at least the following information:

- ▶ The location, within the mechanical spaces, and the type and size of the principle items of heating, ventilation and air conditioning, including fixtures and the necessary control systems and diagrammatic layouts of primary and modular distribution duct and piping systems for such equipment and fixtures, together with the necessary control systems.
- ▶ Heat loss and heat gain calculations of the major heating, cooling and ventilating equipment shall be provided in a report describing the approach for meeting the minimum requirements of the Massachusetts Energy Code
- ▶ All directions of flow and pitch on piping, and direction of flow, and volumes for duct systems shall be indicated. All ductwork shall be shown as double line.
- ▶ Mechanical Room layouts - these drawings should include a Boiler and/or Equipment Room for: boilers to steam to HW converters; refrigeration machines; pumps - HW, CW, CT, expansion tanks; storage tanks; water service; all associated piping and accessories; louvers; flues, stack controls and instrumentation; equipment removal provisions; temperature control system elements, (e.g.: compressors, panels, etc.).
- ▶ Sections through congested spaces
- ▶ Air handling units - these drawings should include FA intakes and louvers; fans and drives; filters; HW and CW coils; controls; associated duct work.
- ▶ Piping distribution systems - these drawings should include the location and size of all piping systems and all valves, accessories and appurtenances
- ▶ Cooling tower - these drawings should include the tower location and size, and associated piping and controls
- ▶ Equipment piping and duct insulation
- ▶ Flow diagram - this drawing should show all the piping systems with necessary instrumentation and control systems
- ▶ Equipment and valve name tags and/or plates
- ▶ Schedules, legends and symbols - this information should accompany air handling units, fans, exhausts, diffusers, registers, pumps, etc.
- ▶ Ducts - these drawings should include all supply and return duct distribution systems with access panels, damper controls, and insulation
- ▶ Ventilation and exhaust systems - these drawings should include toilets, lockers, storage and janitorial rooms; fountains with humidity control; kitchen exhaust; and concourses.
- ▶ Radiation
- ▶ Sleeves, hangers, inserts and equipment supports
- ▶ Shut-off valves and access panels
- ▶ Temporary services
- ▶ All large equipment items - these items shall include sufficient servicing and/or replacement space indicated on the drawings - Also show as a 3D volume view.

8.2.6 | Electrical Drawings

These drawings should be identified as "E" and show at least the following information:

- ▶ The locations, types and sizes of: electrical power equipment with estimates of total electrical load; service connections; power, lighting and signal distribution systems; typical electrical fixtures; total load; conformance to the applicable Electrical Code(s)
- ▶ Security drawings developed with MPA's requirements, including but not limited to plans showing location and type of proposed security devices
- ▶ Lighting systems - the types of wiring, location, types, and sizes of all fixtures, receptacles and switch outlets; mounting heights of all fixtures; sizes and types of all lamps; sizes, types and location of all panels; branch circuit wiring; sizes of feeder conductors and conduits; all other essential special details; system riser diagrams, fixture schedules; details and method of supporting all electrical fixtures and conduits.

- ▶ Power systems - the locations, types and methods of control of all motors, heaters, and appliances; types, sizes, and locations of all controllers; starters, thermostats and other control devices; branch circuit and control wiring; sizes, types and location of all panels; sizes of feeder conductors and conduit; all other essential special details; riser diagrams; panel board and switchboard schedules; details and methods of supporting electrical conduit
- ▶ Signal systems - the locations, types and sizes of all outlets and equipment for TV, telephone, sound, and public address systems; service connections; wiring diagrams; riser diagrams and all other essential details
- ▶ Fire alarm systems - drawings related to Fire Alarm Systems shall provide the level of detail indicated in MPA Standard Spec. Section 01050 - Record Documents and Field Engineering
- ▶ Services - the locations and details of all services; metering arrangements; service switchboard diagrams and arrangement; extent of installations to be provided by power and telephone companies
- ▶ Generator or sub-stations - the locations, sizes and methods of connecting and protecting all generators, transformers, excitors, motor generators, switch gear, and associated equipment; current characteristics and equipment capacities; connections by means of one line and wiring diagrams; schedules of all major items of equipment and all instruments
- ▶ Underground work - the locations, sizes, number and types of manholes, ducts and cables; methods of cable support and fireproofing; duct line profile; one line diagram of connections
- ▶ Pole line work - the locations, lengths, treatment and class of: poles; guying; insulators; circuit; transformers; current characteristics; protective and switching devices; lightning arresters; grounding; special structures; and diagrams
- ▶ Street lighting - the locations, sizes and types of all transformers, luminaries, poles, cables, ducts and manholes, details of control equipment, and connection diagrams
- ▶ Temporary services - all necessary wiring, switches and accessories required for temporary light and power installation during construction
- ▶ Security systems - the locations, types and sizes of all outlets and equipment for security alarm systems located in, but not limited to doors, windows, hardware, roofs, fences and mechanical equipment. All security systems shall be developed in coordination with MPA requirements.
- ▶ All of the above final drawings shall be checked, coordinated and referenced to those drawings and specifications of other disciplines that they affect or interface with.

8.2.7 | Survey Drawings

These drawings should be identified as "Y" drawings and provide at least the following items:

- ▶ North arrow
- ▶ A note describing the spatial datum employed
- ▶ A vertical datum sketch relating the project datum to other relevant datums (Boston City Base, NAVD'88, NGVD'29, MLLW, CA/T, etc.)
- ▶ Survey traverse and traverse spurs, coordinate values of survey control stations, description of the character of the stations with elevations shown. (A copy of traverse is to be submitted to the MPA Survey Unit)
- ▶ Tie sketches to facilitate the recovery of survey control stations
- ▶ Tie sketches to facilitate the recovery of benchmarks
- ▶ Survey notes stating the precision of the survey traverse, sources of record data (plan titles and dates), date of field survey, digsafe note, and any other pertinent information
- ▶ If contract requires a title search, owner and abutter names and deed references (when project abuts property lines), or other matters of land title (easements, etc.) as they may effect design considerations, copies of reference deeds and plans are to be provided to the MPA Survey Unit

Project benchmarks shown (minimum of two) with coordinate values and description of their character. (A copy of level loop is to be submitted to the MPA Survey Unit)

OPTIONAL ITEMS: Mathematical ties from the project survey control to the project baselines, work points, or column lines may be shown on these survey drawings. Alternatively, if such

information is not shown on these drawings, it shall be shown on the appropriate design drawing with reference back to the Survey Drawings in the contract documents.

8.2.8 | Site/Civil Drawings

These drawings should be identified as "C" drawings and show the following items:

- ▶ The location and dimensions of all existing and proposed buildings, structures and features of the project
- ▶ Existing contours and proposed contours; bench marks and other control elements
- ▶ Items of work requiring demolition
- ▶ Foundation drains
- ▶ Site oil/water separators
- ▶ Ground floor elevations
- ▶ Utilities (new and existing)
- ▶ Right-of-ways or easements
- ▶ Site construction, construction contract limits
- ▶ Outside drainage and disposal from land and structures
- ▶ All existing foundations, obstructions and other physical characteristics of the site which may affect the work and which the Consultant, after exercising reasonable diligence, has discovered
- ▶ All development of landscape spaces, features and elements, including, without limitation, all walks, roads, recreation areas, parking areas, retaining walls and exterior lighting and signage
- ▶ All architectural landscaping materials and equipment

8.3 | BIM Submissions and Document Deliverables

MPA requires model and drawing submissions as part of project review and substantial completion for final payment.

These model, drawings, and report submissions, any project specific additions, and the submission schedule will be documented in the BIMxP and be part of project pull planning.

There are typically three minimum model submissions during the project lifecycle:

Criteria Definition Model

is the federated WIP submitted at the end of Criteria Definition phase

Design Intent Model

used for construction documentation and provided to the constructor at the end of the Design Phase

Record Model (.rvt) and the As-Built Model (.nwd)

at the end of the Implementation Phase for final project handover

With each model submission, the current project BIM Manager will update the BIMxP for review. The MPA project manager and DTIG Manager will verify the recommended model element LOD and BIM Use execution.

Clash Detection Report: A clash detection report will be submitted with the model submissions. Clash detection is a continuous operation. The report will be regularly reviewed with MPA per the clash schedule.

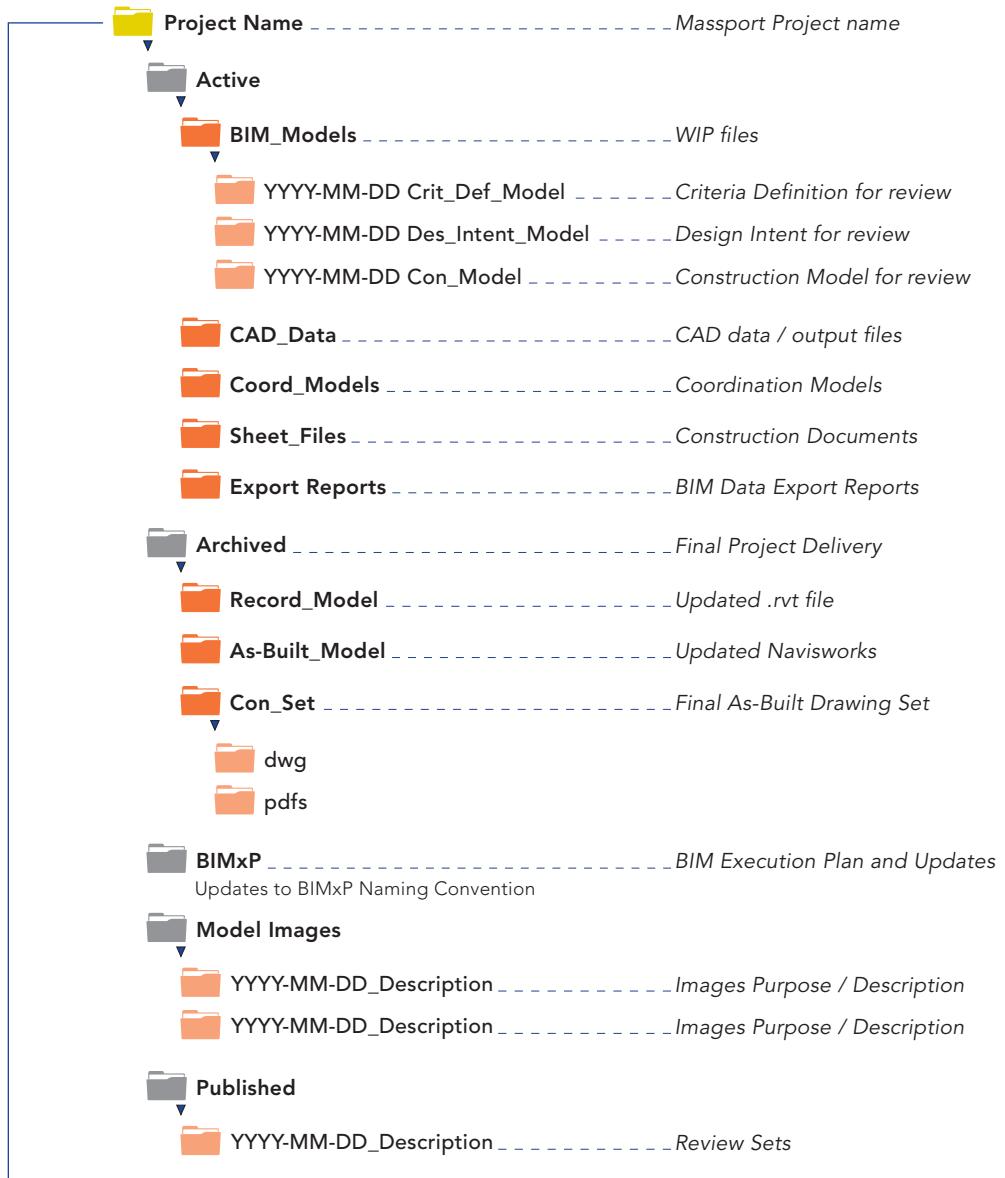
Model Checking: MPA may use model-checking applications during model submission for quality control. The report produced by a final model check may be used to advise the project BIM Managers of defects and discrepancies in the model to be adjusted. Rule sets used in checking the model shall be agreed upon by the project team and specified as part of the BIMxP.

Model Submission Structure: The model shall maintain the linkage to all discipline models. At each submission, the model will be delivered in native format (.rvt), and a review format (.nwd), (optional .ifc²⁷). Drawing progress sets shall be submitted as .dwf, .dwg files, or .pdf. Progress data reports, COBie or equipment list template, pull-plan schedules and quantities may be submitted in .xls, .docx, and .pdf.

Integration into the MPA environment: The BIMxP should include the software and associated add-ons, add-ins, plug-ins, stock and custom object libraries, and other application-supporting modules that have been used in producing the BIM with specific version and software "build" numbers. The project BIM Manager will be responsible for submission of project documentation in digital, paper, and Mylar formats (record drawings) as required for the project.

8.3.1 | Project Folder Structure for Submissions

Massport has developed a recommended file folder structure for delivery of BIM submissions, reports, images, and data. The folder structure is supported in the MPA BIM environment. There are no spaces in the folder names. The structure will be reviewed by the BIM Manager as part of the BIMxP development for the specific project.



If a project requires additional sub-folders these shall be documented in the BIMxP for approval by the DTIG Manager.

²⁷ IFC – INDUSTRY FOUNDATION CLASSES FILE MAY BE REQUIRED ON SOME PROJECTS FOR MODEL QUALITY REVIEW AT HANDOVER.

8.4 | Model Submissions

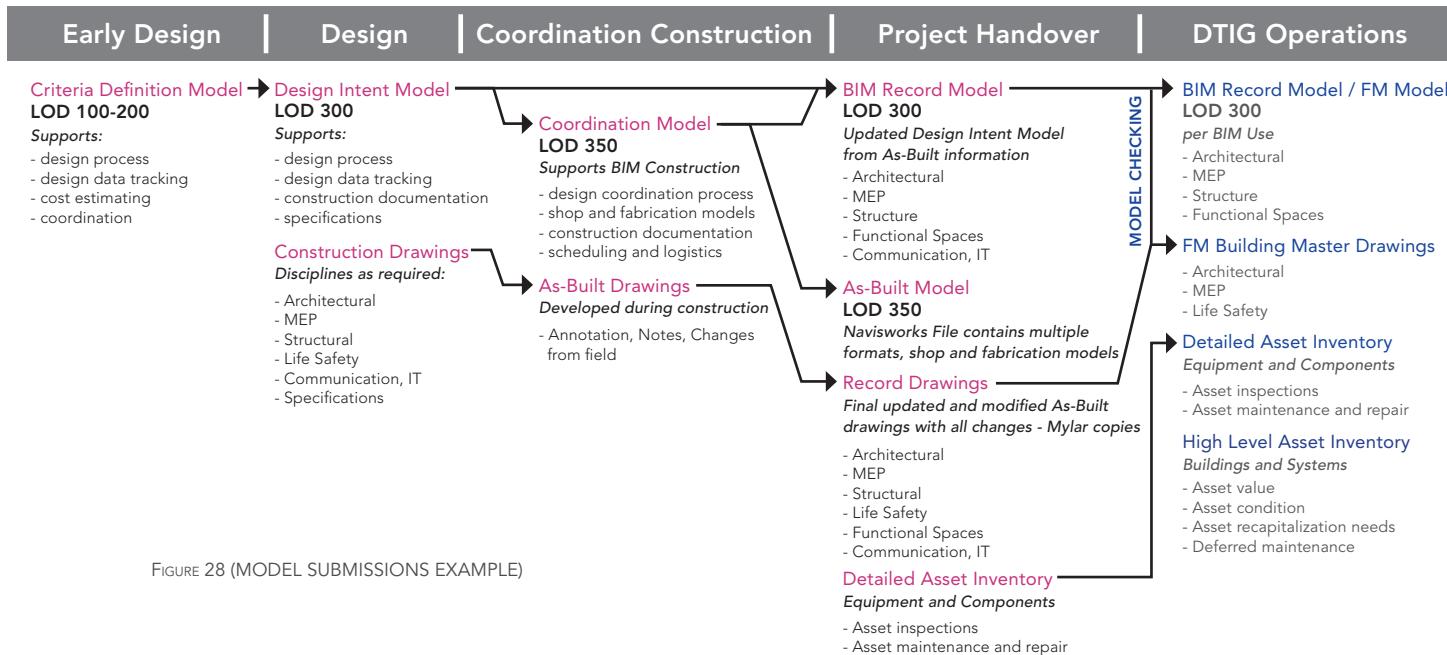


FIGURE 28 (MODEL SUBMISSIONS EXAMPLE)

8.4.1 | Conceptualization and Criteria Definition Model Submission

The criteria definition model includes the modeling required to verify the project program, preliminary space validation, preliminary estimate, design options, defined BIM Uses and analysis for this phase per the project pull plan and BIMxP.

8.4.2 | Design Intent Model Submission

The design intent model represents fully coordinated 3D architectural, structural, MEP, required discipline models and civil (project specific). This model represents the final design and is the basis for construction documentation. The design intent model and its derivative drawings shall be submitted in native format and be fully operable, editable, and compatible with the Massport environment.²⁸

Equipment schedules shall be derived from the equipment attributes and parameters in the Revit components/objects/elements in the model and comply with the MPA equipment and FM requirements.

- ▶ 3D model views will be incorporated into construction drawings and details to support team communication.
- ▶ The final construction documentation set shall also be submitted in .pdf. Final data shall be submitted per MPA asset spreadsheet or COBie in .pdf and .xls²⁹ as appropriate for content and application.

8.4.3 | Record Model Submission (LOD 300)

The design intent model (.rvt) is an element LOD 300 model updated with as-built locations for building elements within the model. This updated model is submitted to MPA and reviewed for product data requirements, model versioning, and integration into the MPA environment for operations. The Design or Constructor team should finalize this record model for handoff to MPA as part of the final submission process.

²⁸ SOFTWARE RELEASE VERSIONS WILL BE PROVIDED AT TIME OF PROJECT BY DTIG MANAGER.

²⁹ ".XLS" AND ".XLSX" ARE HEREIN UNDERSTOOD TO INDICATE THE FILE TYPE EXTENSION OF THE MICROSOFT EXCEL VERSION PRESCRIBED BY DTIG AND DOCUMENTED IN THE BIMxP FOR THE PROJECT.

The Design and Constructor BIM Managers will work together to assure that the record model contains the necessary building element updates, product, space, and FM data. The model links should be unbroken.

8.4.4 | Data Deliverables

The MPA asset data spreadsheet or COBie data standards are to be used to capture data for MPA projects. This will be determined at project inception. What is to be used for a project will be a joint decision of the DTIG Manager, the MPA EAM Project Manager and the Design BIM Manager and will be documented in the BIMxP.

COBie Data - Current COBie worksheets shall be submitted by the Design BIM Manager at the end of design phase, and the Constructor BIM Manager at the end of construction with special emphasis on spaces, MEP, and equipment for facilities handover. The data will be delivered in the COBie spreadsheet or a model report supporting the MPA equipment requirements. The following data levels coincide with model submissions.

- Level 1
Master Attributes and Asset Management Attributes within the design model
- Level 2
Balance of COBie or MPA information required throughout the project by the responsible party defined in the BIMxP
- Level 3
At project closeout the agreed upon COBie or MPA spreadsheets are populated with the required data from the model with additional fields required for the project by MPA.

8.4.5 | As-Built Model (.nwd) (LOD 350)

The As-Built model and drawings provide an archival record of what was actually constructed at a higher LOD than the record model. It may contain additional file formats from shop models and fabrication detailing with information coordinated in the project, where exactly the new or renovated work is located.

8.4.6 | As-Built Drawings

The constructor must maintain, as an ongoing update, one complete master set of contract drawings that records all Addenda, Change Orders, Field Orders and other such changes.

Before MPA endorses the work as "complete," the Contractor must submit all of the Contractor-prepared As-Built prints and/or electronic files. These include: 4-mil Mylar drawings, electronic AutoCAD files, and scanned 200 dpi TIFF files of As Built Mylar drawings.

Each updated As-Built Mylar drawing must include a Contractor-signed certification statement that confirms the completeness and accuracy of documented As-Built conditions. Such statement shall read, "This Drawing reflects As-Built Conditions as certified by (insert contractor's name) and as submitted on (insert date of submission)."

The Consultant then delivers to the Authority the certified As-Built Drawings, Models and other deliverables.

8.5 | Additional Model Drawing Submissions

Based upon project needs, additional model deliverables may be required.

8.5.1 | Bid Model Submission

The 100% Construction Documents and the coordinated Design Intent Model submitted by the Design BIM Manager may be made available to the constructor and sub-contractors for bidding purposes. The constructor/CM is responsible for trade review. The files shall be noted that the use of this information is done at the sole risk of the constructor and its trades.

8.5.2 | Commissioning BIM

The model or model data may be used during the commissioning process. This is a coordination effort and will be documented in the BIMxP.

8.5.3 | Record Model Drawings

MPA may require a set of Record Drawings or other partial drawing sets from the Record model. This will be defined in the BIMxP.



3D Model	A three-dimensional (3D) digital representation of a building or structure generated by modeling applications. A 3D model is geometry focused and does not require any level of intelligence.
A3	A one-page report prepared on a single 11 x 17 sheet of paper that adheres to the discipline of PDCA thinking as applied to collaborative problem solving, strategy development or reporting. The A3 includes the background, problem statement, analysis, proposed actions, and the expected results.
A/E	Abbreviation stands for Architect/Engineer
AGC	Associated General Contractors
Activity	An identifiable chunk of work with recognized prerequisites to begin and a recognized State of Completion - or Conditions of Satisfaction. Another way to look at an activity - establish the hand-offs for each chunk of work thus defining the activity. (see also "task")
As-Built Model	Model(s) based on Fabrication Shop Model(s) and installed conditions.
Assignment	A request or offer resulting in a Reliable Promise and is ready to be placed on the Weekly Work Plan (WWP) for performance. An assignment must meet the characteristics for a Quality Assignment prior to inclusion on the WWP.
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers is a professional organization that develops and promulgates system, measurement, and product engineering standards to the industry.
BAS	Building Automation Systems
BIM	Building Information Modeling is the process that results in the creation of a Building Information Model, used for effective and efficient designing, constructing, managing, and representing a facility throughout its lifecycle. The BIM Process includes a collection of defined model uses, workflows, and modeling methods used to achieve specific, repeatable, and reliable information results, support design decisions, and improve construction and facility operations.
BIMxP	A BIM Execution Plan (BIMxP) is a project specific document using the BIMxP template that describes how BIM will be implemented throughout the project's lifecycle. It documents the implementation strategy for all parties involved in contributing to the model, information derived from the model, analysis, or a project that utilizes the BIM process.
BIMxP Template	A template provided by Massport to the Primary Design Consultant as a basis for development of the project BIM Execution Plan (BIMxP).
BIM Manager	The person who administers all information rich BIM and 3D CAD models for projects. The BIM Manager is responsible for the management of CAD and BIM information flow, including flow standards, process enforcement, and specifications for reports required by others.
CAFM	Computer-Aided Facilities Management

Closure Phase	See OmniClass Phases.
Constructor	The Constructor is the entity responsible for the construction of the project who has a direct contract with Massport.
Construction Manager at Risk	<p><i>Various key characteristics of CM@Risk include:</i></p> <ul style="list-style-type: none"> a there are separate contracts for design services and for construction services; b the contract for construction services may be entered into at the same time as the contract for design services, or at a later time; c design and construction of the project may be in sequential phases or concurrent phases; and d The services of finance, maintenance, operations, pre-construction, and other related services may be included.
CMMS	Computerized Maintenance Management System
COBie	Construction Operations Building Information Exchange (COBie) is an information exchange specification for the lifecycle capture and delivery of information needed by facility managers. COBie data can be viewed in design, construction, and maintenance software as well as in simple spreadsheets. COBie is sometimes referred to as "the COBie spreadsheet." COBie data is all the data that is needed to properly operate the building or facility and traditionally has been handed over to the building Owner (or a designee) in paper format. BIM processes support the COBie philosophy of collecting the relevant information as it is produced and developed during design, construction, and commissioning, rather than re-gathering the required data as the building is being occupied. BIM allows extraction of relevant COBie data from the model into an organized electronic spreadsheet form. The "COBie spreadsheet" that is typically generated by the various BIM-to-COBie utilities is not frozen or static. It can be expanded in a variety of ways to meet the building operator's information needs.
Co-Location	Assembling the entire BIM design and construction team in a single location ("Co-location") enables almost instant and direct communication and coordination among team members. This Co-location of all team members provides the environment, opportunity, and proximity to build trust among teammates, while efficiently designing. The project issues are nearly transparent and solutions start to evolve in near real time because everyone is working in the same physical space. Some costly logistics such as travel to and from an external meeting address are essentially eliminated. Regular whole-team meetings, and more restricted discipline team meetings, can have standing schedules that permit brief broadcasts of information that get everyone in sync. Such "big room" meetings help downstream participants appreciate upstream obstacles and solutions, as well as enabling downstream participants to propose field-level solutions that designers may have underappreciated.
Commissioning	A building has successfully gone through the commissioning process when its equipment and systems have been examined and tested to perform as designed, and its operators have been trained to operate the systems and equipment properly. Lawrence Berkeley National Laboratory cites Hasl and Heinemeier's "California Commissioning Guide: New Buildings" as an authoritative source. AEC recommends applying a rigorous commissioning process to the BIM as well as to the building for the same operational quality assurance reasons. Note the excellent advice in the cited source that eventual recommissioning should be anticipated in a well-done initial commissioning process. (see also "Retrocommissioning")
Complete	A Performer states that they have completed the work requested and the requester declares it complete (or done) according to the agreed to Conditions of Satisfaction.

Conceptualization Phase	See OmniClass Phases.
Conditions of Satisfaction	An explicit description by a Customer of all the actual requirements that must be satisfied by the Performer in order for the Customer to feel that he or she received exactly what was wanted.
Confidential Digital Data	Confidential Digital Data is Digital Data containing Sensitive Security Information ("SSI") as defined by 49 USC s.1520.
Construction Agreement	Construction services agreement between the Owner and the Constructor.
Construction Model	The digital Model(s) developed and maintained by the Constructor, representative of the physical and functional characteristics of a facility or infrastructure to support decision-making and construction activities, support interdisciplinary coordination, and track as-built conditions and asset data.
Coordination Phase	See OmniClass Phases.
Criteria Definition Phase	See OmniClass Phases.
CSI	The Construction Specifications Institute publishes authoritative MasterFormat® and Omniclass™ documentation as well as other construction-oriented organizational information tools.
Customer	The individual engaged in a conversation for action who will receive the results of performance either requested from, or offered by, the Performer.
Design Agreement	Design services agreement between the Owner and the Owner's Prime Design Consultant.
Design-Bid-Build (DBB)	<ul style="list-style-type: none"> a There is a sequential award of two separate contracts; b the first contract is for design services; c the second contract is for construction; d design and construction of the project are in sequential phases; e finance services, maintenance services and operations services are not included.
Design Build (DB)	<ul style="list-style-type: none"> a There is a single contract for design services and construction services; b design and construction of the project may be in sequential phases or concurrent phases; c Finance services, maintenance services, operations services, design services, pre-construction services, and other related services may be included.
Design Model or Design Intent Model	The digital Model(s) authored by the A/E, representative of the designed physical characteristics of a facility or infrastructure and linked to database of properties to communicate design intent, increase design visualization, promote interdisciplinary collaboration, and aid in controlling cost and schedule.
Design Phase	See OmniClass Phases.
Digital Data	Digital Data is information, including communications, drawings, specifications and designs, created or stored for the Project in digital form. Unless otherwise stated, the term Digital Data also includes the Model(s) and/or Model Element(s).

Discipline Model	There is a discipline model for each of the major disciplines in the project: Architecture, MEP Engineering, FP engineering, Structural engineering, etc. Each sub-consultant is responsible for his or her discipline model accuracy and data reliability.
DOE/DOE-2/DOE2	(U.S.) Department of Energy has produced a standard methodology for calculating energy use in buildings. Several energy analysis software applications implement that methodology and variants thereof. Some can be found at http://www.doe2.com/ For underlying assumptions, see http://hes-documentation.lbl.gov/Home-Energy-Saver/calculation-methodology/calculation-of-energy-consumption/heating-and-cooling-calculation/doe2-inputs-assumptions-and-calculations
DTIG	Design Technologies Integration Group, as of this writing is envisioned as the group that will be coordinating an integration, normalization, and fusion of policies, procedures, and execution for CAD, GIS, and BIM.
Drawing	A drawing is a 2D representation of the intended design for a facility at various phases in its life. Drawings are generated from standard plan-, section-, and elevation-cuts through a model, as well as from non-standard cuts and views required elucidating the design.
DWF	DWF is short for Design Web Format, created by Autodesk. DWF is a compressed, non-editable, vector file format created by CAD and BIM applications. A DWF file can represent sheets for plotting purposes (2D DWF) or the entire 3D Model (3D DWF) for visualization or estimating purposes.
DWG	DWG ("drawing") is a binary file format licensed by Autodesk and used for storing two and limited three-dimensional design data and metadata. It is the native format for several CAD packages, primarily AutoCAD™. In addition, DWG is supported non-natively by many other CAD applications.
Fabrication Model	Digital Model(s) created from shop drawings to support fabrication and installation. Fabrication models are reviewed and approved by the A/E for conformance to design specifications.
Facility Attribute Data	Attribute data associated to BIM elements and intelligent objects. This refers to attribute data of interest and importance to Facility Managers for all aspects of building continuity of operations, sustainability, and health, safety, and comfort. COBie data is an example dataset of such attributes.
Facility Lifecycle	This refers to the time span stretching from a building's conception to demolition including the five distinctive phases (Planning, Design, Construction, Operations, and Disposition).
Federated Model (Integrated and Coordinated)	A model is federated when two or more of the discipline models are electronically shared into the architectural model in order to: <ul style="list-style-type: none"> a show context; supporting documentation and views of the design intent b perform analyses; c provide other visual comparisons; and d to verify proper integration and coordination of its subsystems with each other. A federated model is a model management technique that enables limited computing resources to cope with the increasing complexity, fine levels of detail, and higher Levels of Development needed to represent the built environment. When reviewed and clash detection is performed, then the model is the basis of the Design or Design Intent model and construction documentation is derived from this federated model.

FFE	Furniture, Fixtures, and Equipment
Flow	Movement that is smooth and uninterrupted, as in the "flow of work from one crew to the next" or the flow of value at the pull of the customer.
FM	Abbreviation for Facilities Management
Geo-referencing	A BIM is said to be geo-referenced when the BIM is located with respect to one of the standard geographic survey coordinate grids established to represent locations on the Earth's surface, such as World Coordinate System 1984 (WCS84)
GUID	Globally Unique ID is a unique identifier that software creates and uses to track entities, elements, data fields, and everything else in a BIM. Every placed instance of every object has a GUID. The GUID may be a long string of characters that tracks the entity, its type, software version, and other BIM entities related to it (a parent object, an enclosing space, e.g.). The GUID is typically hidden from the user. In part, the GUID is what allows the software to know that it is this entity instance whose name was changed, or was resized, or moved. From the BIM perspective, the GUID permits BIM data-round-tripping to other applications and back to the BIM.
Handover Phase	See OmniClass Phases.
Hand-off Criteria	The Conditions of Satisfaction discussed and explicitly agreed between the parties to a hand-off.
Heliodon	Still or moving images of studies generated by BIM software showing shadow lines cast by and on a building based upon the geographic location of the building, its orientation with respect to the sun, at a date and time. The images may be vector or raster or a combination of both.
IFC	Industry Foundation Class. Industry Foundation Class is an open, neutral, and standardized specification for Building Information Models. The foundation classes characterize design and construction objects in an open, non-proprietary way, to facilitate exchange of graphic and non-graphic data among differing BIM authoring software in such a way that reliable analyses can be performed on the model as it passes from one BIM system to another.
Implementation Phase	See OmniClass Phases.
Inception Phase	See OmniClass Phases.
IPD	Integrated Project Delivery (IPD) is a collaboration of all parties, systems and practices to optimize and maximize project success. Defined by the American Institute of Architects (http://www.aia.org/about/initiatives/AIAS078435?dvid=&recspec=AIAS078435), IPD is typically applied to design and construction projects. NOTE: True IPD employs various constructs some of which MPA may be precluded from using by Commonwealth law (such as the use of multi-party contracts, and profit sharing). MPA's project delivery approach may leverage some aspects of IPD that are allowed by law (such as co-location and BIM).
Interoperability	The ability of two or more systems or components to exchange information and to use the information that has been exchanged. (Institute of Electrical and Electronics Engineers, IEEE Standard Computer Dictionary: A Compilation of IEEE Standard Computer Glossaries, New York, NY: 1990)

IWMS	Integrated Workplace Management System. Such systems incorporate powerful database capabilities to capture enterprise-level functions, and serve as decision support tools at all organizational levels and throughout the whole building lifecycle. An IWMS thus reaches into all organizational databases to feed its enterprise level analyses.
Last Planner®	The person or group that makes assignments to direct workers. Project Architect and 'discipline lead' are common names for last planners in design processes. 'Superintendent' or 'foremen' are common names for last planners in construction processes.
Last Planner System® (LPS)	The collaborative, commitment-based planning system that integrates "should-can-will-did planning" (pull planning, make-ready look-ahead planning with constraint analysis, weekly work planning based upon reliable promises, and learning based upon analysis of Percentage of Plan (or Promises) Completed (PPC) and Reasons for Variance.
Lean Project Delivery System	An organized implementation of Lean Principles and Tools combined to allow a team to operate in unison.
LEED	Leadership in Energy and Environmental Design (LEED) is a rating system for the design, construction and operation of buildings or facilities. Developed by the U.S. Green Building Council (USGBC), LEED provides owners and operators a guide for practical measures for sustainable practices.
LOD (Level of Development)	Level of Development defines the reliability of information and the level of completeness to which a model element is developed. Completeness ranges across element information and its corresponding geometry.
Load	The amount of output expected from a production unit or individual worker within a given time.
Look Ahead Planning	The portion of the Last Planner System that focuses on making work ready - assuring that work that should be done, can be done, by identifying and removing constraints in advance of need.
Look Ahead Plan	A short interval plan, based on the pull/phase plan, that identifies all the activities to be performed in the next 6 (or other) weeks. The 6W Look-Ahead Schedule (LAS) is updated each week - always identifying new activities coming 6 weeks out so that the project management team can make appropriate arrangements to assure that the work will be ready to be performed in the week indicated.
Look Ahead Window	This is the duration associated with Look Ahead Planning. Typically, look-ahead windows extend from 3 to 12 weeks into the future.
MasterFormat®	MasterFormat®, published by CSI and CSC, is a master list of numbers and descriptive titles classifying work results. It is primarily used to organize project manuals and detailed cost information, and to relate drawing notations to specifications.
Master Schedule	A schedule that identifies major events or milestones in a project such as significant design events, start-up, turn-over to client, order long lead-time components, mobilize in field, complete design, government reviews, and their timing. It is often the basis for contractual agreements between the owner and other team members.
MEPF	Mechanical, Electrical, Plumbing and Fire

Milestone	A milestone is an item on the Master Schedule that defines the end or beginning of a phase or a contractually required event.
Model Delivery Schedule	A schedule developed as part of the project's BIMxP which defines the intervals and LODs at which Model(s) and/or Model Element(s) will be shared by the Project Participants and reviewed by Massport throughout both design and construction phases, and finally at project completion and handover.
Model Element	A model element is a portion of the model(s) representing a component, system, or assembly within a building or site
Native file format	Typically proprietary, this refers to the internally formatted and structured file created or selected by the software developers and produced by their software. The internal organization, format, and structure of such a file is controlled by the software developer, although it can be licensed to other developers if they also select it as their native file format (ZWCAD uses DWG as its native file format, e.g.). Users typically differentiate one file format from another by the 3 or 4 letter Microsoft Windows™ file extension. The native file format of Autodesk Revit™, for example, is designated by ".rvt" while the native file format of Microsoft Office WORD 2010 is ".docx."
NAD	The North American Datum (NAD) is the official horizontal datum used for the primary geodetic network in North America. The latest published network is NAD83; however, the prior version NAD27 is still widely used. Each system is based on a separate set of measurements but is still are geodetic reference systems.
NAVD88	North American Vertical Datum 1988, which is more accurate than NAVD29 and amenable to GPS readings and enables easier comparisons between local Datums.
NCS	The United States National CAD Standard Version 5.0 is sponsored and created by NIBS. "National CAD Standard® (NCS) V5 consists of The American Institute of Architect's CAD Layer Guidelines, the Construction Specifications Institute's Uniform Drawing System (Modules 1-8), and the National Institute of Building Sciences' Plotting Guidelines." See http://www.nibs.org
NBIMS	National BIM Standard – United States Version 2 is sponsored by National Institute of Building Sciences (NIBS) under its BuildingSMART Alliance Council.
Network of Commitments	The web of promises necessary to deliver any project. The role of management is to articulate and activate the unique network of commitments required to deliver each project.
NWC	NWC is a cache file. "When you open a CAD file in Navisworks, by default, a corresponding cache file (NWC) is created, which contains all of the conversion details required by Navisworks. When you subsequently open that CAD file in Navisworks, it will check to see whether a cache file is available. If it is, then Navisworks will check to see whether the CAD file has been modified since it was last opened in Navisworks."
NWD	NWD designates the published version of a Navisworks file with all loaded models, viewpoints, redlines, and comments saved to a single file. This file type can be opened with any of the Navisworks products including Navisworks Freedom (the free viewer).

NWF	When saving to a "Navisworks file format (NWF), only a list with pointers to the files currently loaded is saved, along with the scene's environment, the current view, clash results, if available, and favorite viewpoints (including redlines and comments). To open an NWF file, a Navisworks product is required, such as Review, Simulate, or Manage (not Freedom), as well as access to the original CAD files." http://knowledge.autodesk.com/support/navisworks-products/troubleshooting/caas/sfdarticles/sfdarticles/Difference-between-NWD-and-NWF-file-formats.html
OmniClass	The Omniclass Construction Classification System (OCCS) is developed and maintained by the Construction Specifications Institute (CSI). Omniclass is a modern, systematic, extensible classification system for the construction industry that incorporates several legacy classification systems developed by various industry groups under their respective trademarked names. Key tables are Table 13 - Spaces by Function, Table 22 - Work Results, Table 11 - Construction Entities by Function, and Table 23 - Products. See http://www.omniclass.org
OmniClass Phases	Phases defined by OmniClass Table 31 which define a period of time within the duration of a design and construction project identified by the overall character of the processes and procedures occurring within the identified period. These phases are defined as Inception Phase, Conceptualization Phase, Criteria Definition Phase, Design Phase, Coordination Phase, Implementation Phase, Handover Phase, Operations Phase, and Closure Phase. See http://www.omniclass.org Table 31 – Phases
Operations Phase	See OmniClass Phases.
Owner	Massachusetts Port Authority (also referred to as Massport or MPA)
Party	The term "Party" and "Parties" refer to the entities executing the Agreement, to the extent they intend to use Digital Data on a project.
PDF	PDF the Portable Document Format file type, created by Adobe Systems. It is an open standard file format for document exchange independent of authoring software that created the source. Most significant BIM software supports saving as, or publishing as, .PDFs.
Phase	A period of the project where a specific group of activities is scheduled to be accomplished. A Phase is defined by a goal/milestone.
Phase Plan or Pull Plan	A plan for executing a specific phase of a project using a pull technique to determine hand-offs. It is prepared by the team actually responsible for doing the work through conversation. Work is planned at the "request" of a downstream "customer."
Plan Reliability	A period of the project where a specific group of activities is scheduled to be accomplished. A Phase is defined by a goal/milestone.
Planning	The act of conversation that leads to well-coordinated action.
PPC (Percent Plan or Promises Complete)	A basic measure of how well the planning system is working, calculated as the "number of assignments completed on the day stated," divided by the "total number of assignments made for the week." It measures the percentage of assignments that are 100% complete as planned.

Prime Design Consultant	The Prime Design Consultant is the entity responsible for the design of the project who has a direct contract with Massport.
Process mapping	A flowchart identifying all the activities, operations, steps, and work times for a process.
Promise	The action taken by "Performer" to commit to a "Customer" to take some action to produce a mutually understood result ("Conditions of Satisfaction") by a definite time in the future. (See Reliable Promise, below).
Project Team Member	An organization or individual person that is part of the team.
Project Participant	Any person who is involved with the project and receives, uses, or manages digital data.
"Push"	"Push" - an "Order" from a central authority based on a schedule; advancing work based on central schedule. Releasing materials, information, or directives possibly according to a plan but irrespective of whether or not the downstream process is ready to process them.
QTO	Quantity take-off. To the extent that the BIM faithfully represents the intended design, and is created to support QTO as a Use Case for the BIM, then counting the material in the model will correspond to counting the material in the proposed building.
Quality	Conformance to a Customer's valid and agreed upon Conditions of Satisfaction.
Record Model	A Revit (.rvt) model(s) representing installed conditions at the completion of a project.
Request	The action taken by a Customer" to ask a "Performer" to take some action to produce a mutually understood result ("Conditions of Satisfaction") by a definite time in the future.
Sheets (Sheet Sets)	A collection of tangible media-based 2D representations of the intended design of a facility at various phases in its life, derived from the Design Intent Model (includes titleblock, etc.). Sheet sets include metadata traditionally found in title block such as author, firm, permit stamps, sheet number, and references to other sheets.
Sub-Consultant	Team members that are contracted to the Prime Design Consultant, to provide expertise and services on the project.
Sub-Contractor	Team members that are contracted by the Constructor, to furnish labor, materials, and/or equipment to the project, regardless of whether they are subcontractors or trade contractors as defined under Massachusetts CM at Risk Statute.
Target Cost	Lean Term - The cost goal established by the delivery team as the "target" for its design and construction efforts
Trade Model	Digital Model(s) prepared by a Subcontractor, based on Design Model(s) that are interpreted and further defined to support coordination, fabrication and installation. Trade Model(s) are reviewed and approved by the A/E and Contractor for conformance to design specifications and constructability.

Use Case or BIM Use	A Use Case is a description of an intended use of the BIM, along with a description of the type(s) of data that must be in the BIM in order to effectively support that use, responsible parties, and expected outcomes.
Value	What the Customer wants from the process, and will pay for.
Value Stream	Includes all the processes and activities used to design, produce and deliver the product or service to the Customer.
Value Stream Mapping	A diagram of every step involved in the material and information flows needed to bring a product from request to delivery.
VDC	Virtual Design and Construction (VDC) is the use of design models and project information to apply construction processes in a virtual environment to reduce time, cost, and ensure design intent. The specific concept is to inexpensively prevent, and if necessary, to expose and fix errors and omissions in an electronic representation of a project rather than in the (more expensive) construction phases in the field.
Visual Management	Placing tools, parts, production activities, plans, schedules, measures and performance indicators in plain view, assures that the status of the system can be understood at a glance by everyone involved. Actions can thereby be taken locally in support of system objectives.
Virtual Network	A virtual environment through which Project Participants operate remotely by utilizing virtual meeting spaces, networks, and shared sites to manage project meetings and to share project information.
Waste	The opposite of value. There are eight basic types of waste: 1 motion 2 waiting 3 transportation of goods 4 over processing 5 under utilization 6 overproduction 7 inventory 8 defects
Weekly Work Plan	The weekly work plan is the commitment-level ("will") planning step of LPS (see LPS). It identifies the promised task completions agreed upon by the Performers. The WWP is used to determine the success of the planning effort and to determine what factors limit performance. It is a more detailed level than the Look-ahead and is the basis of measuring PPC (Percent Plan or Promises Complete)
Weekly Work Planning	The process by which the Last Planner establishes the plan for the coming period.
Work flow	The movement of information and materials through networks of interdependent specialists.
Work in Progress (WIP) Models	The discipline models are considered works in progress even as federated models but before they are reviewed and finalized for integration into the design intent model.

